8-16-1968

Guidance and Control System (GC) - Comments for malfunction procedure

National Aeronatics and Space Administration (NASA)

CHANGES TO PROGRAM – CMN.

NO
1. TAKE OUT 5 MINUTE LOCK OUT.

?
2. UPDATE STATE VECTOR – PERMIT INTEGRATED POINT TO BE RETAINED (ORBIT PARAMETER DISPLAY)

NO
3. CALL UP N-64 AFTER 60,000 – AFTER 71 FLASH.

4. THE PROGRAM PROCEEDS WITH A MANUVER IN P-61 W/O A V-33.

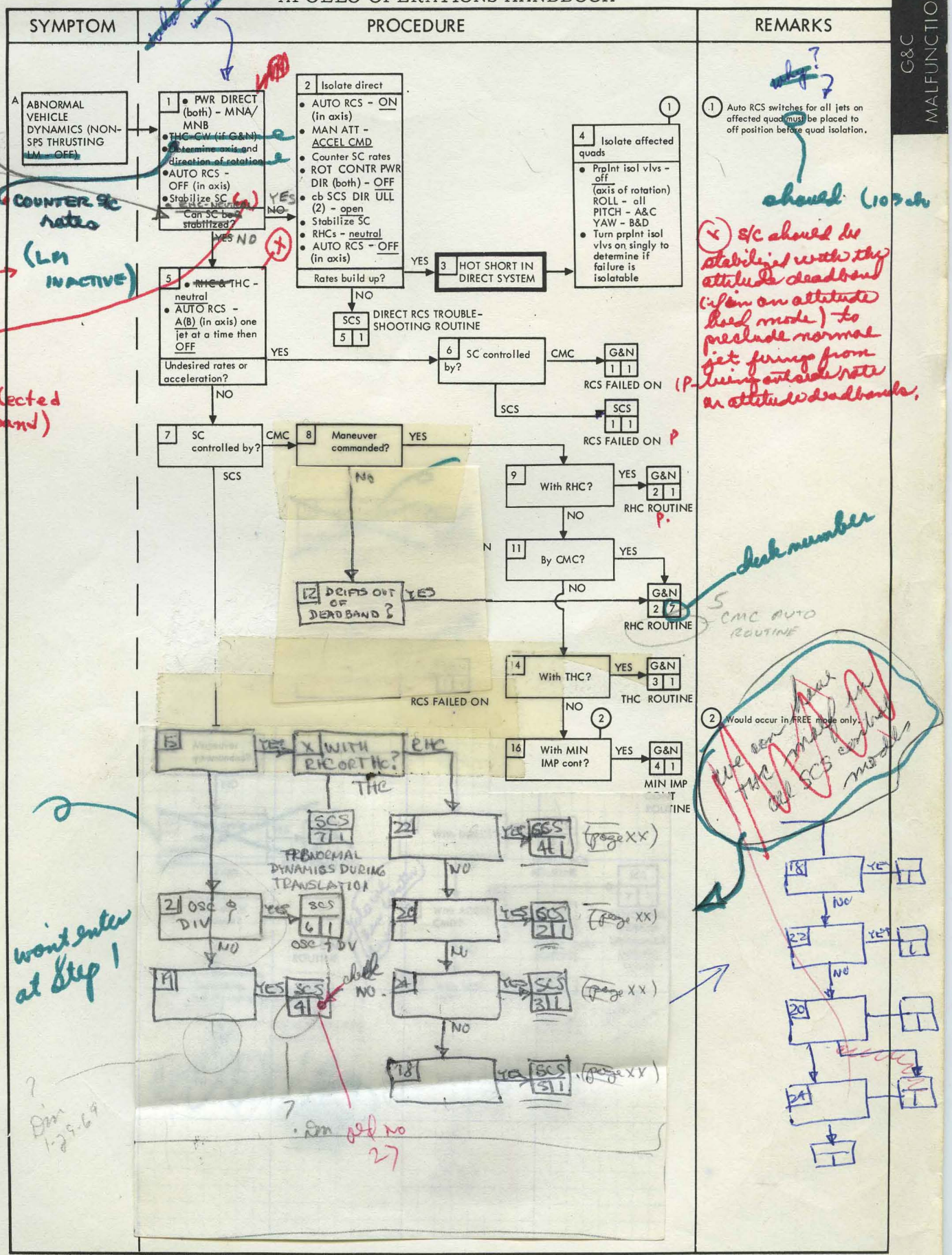
5. THE ATTITUDE MANUVERS ARE SLOPPY IN CEIN.

6. CAN YOU BACK UP A TIG IN A RCS DE-ORBIT

NO
7. P-23 PERMIT CONTINUOUS MARKS RATHER THAN EXITING THE PROGRAM & STARTING OVER.

NO
8. DISPLAY V, h, & γ DURING LAUNCH.

NO
9. VERB 60 SERIES
- CHANGE VERB 67 TO PERIOD
- DO WE NEED V-65.



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FORM 2997-E New 11-67

SYMPTOM	PROCEDURE	REMARKS

A ABNORMAL VEHICLE DYNAMICS (NON-SPS THRUSTING LM – OFF)

1 • PWR DIRECT (both) – MNA/MNB
• THC-CW (if G&N)
• Determine axis and direction of rotation
• AUTO RCS – OFF (in axis)
• Stabilize SC

2 Isolate direct
• AUTO RCS – ON (in axis)
• MAN ATT – ACCEL CMD
• Counter SC rates
• ROT CONTR PWR DIR (both) – OFF
• cb SCS DIR ULL (2) – open

4 Isolate affected quads
• PrpInt isol vlvs – off (axis of rotation)
ROLL – all
PITCH – A&C
YAW – B&D

(1) Auto RCS switches for all jets on affected quad must be placed to off position before quad isolation.

(2) Would occur in FREE mode only.

15 Maneuver commanded? YES / NO

16 With MIN IMP cont? YES → G&N 4 1 MIN IMP CONT ROUTINE

THC ROUTINE

17 Limit cycle on edge of deadband? YES → SCS 1 1 RCS FAILED ON

18 With DIRECT? YES → SCS 5 1 DIRECT RCS ROUTINE

19 Drifts out of deadband? YES → SCS 3 1 RATE CMD ROUTINE

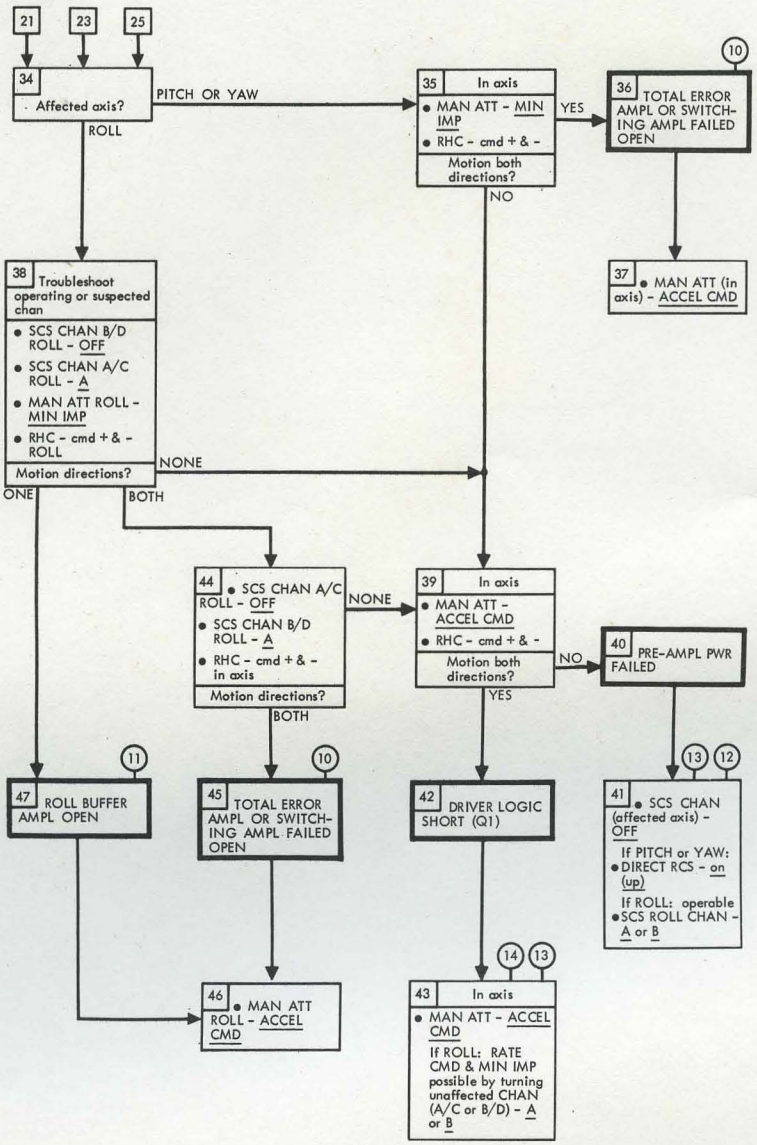
20 With ACCEL CMD? THC → SCS 7 1 ABNORMAL VEHICLE DYNAMICS DURING TRANS; RHC → SCS 2 1 ACCEL CMD ROUTINE

21 Oscillating and diverging limit cycle? YES → SCS 6 1 OSCILLATING AND DIVERGING

22 With MIN IMP? YES → SCS 4 1 MIN IMP ROUTINE

23 Unexpected translation? YES → SCS 3 4 RATE CMD ROUTINE

24 In RATE CMD WITH THC → SCS 7 1 TRANSLATION ROUTINE; WITH RHC → SCS 3 1 RATE CMD ROUTINE

SYMPTOM	PROCEDURE	REMARKS
SCS 3 (Cont)		(10) All RATE CMD and ATT HOLD capability lost for affected axis. Translation possible with MAN ATT sw in RATE CMD and att cont in affected axis by direct. (11) One polarity lost in RATE CMD and MIN IMP. Translation capability remains but ATT HOLD lost. (12) Auto coil capability lost for affected sys (PITCH, YAW, A/C ROLL, B/D ROLL). (13) Translation capability from affected thrusters lost except with DIRECT ULLAGE. (14) RATE CMD and MIN IMP lost for affected CHAN (PITCH, YAW, A/C ROLL, B/D ROLL).

SM-2A-1539B

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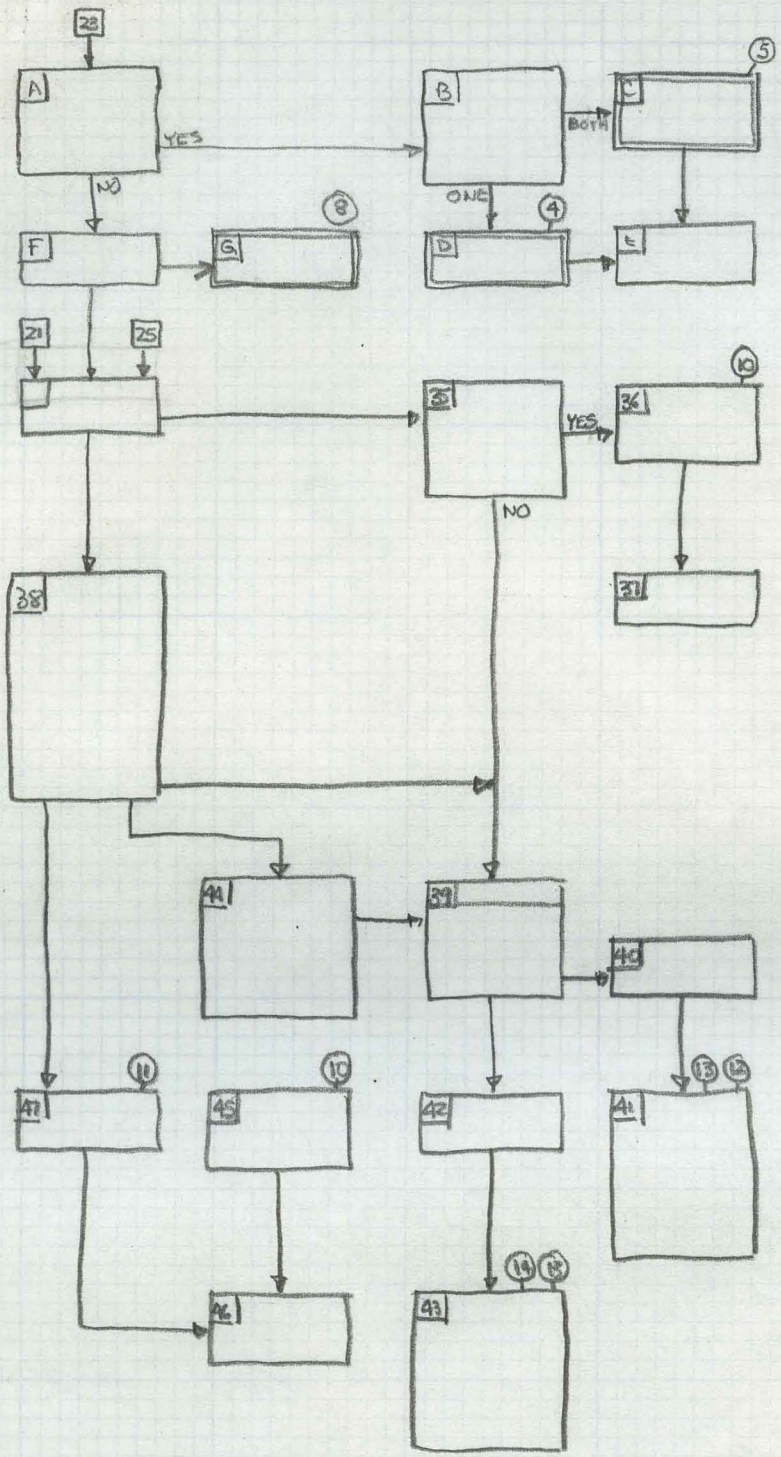
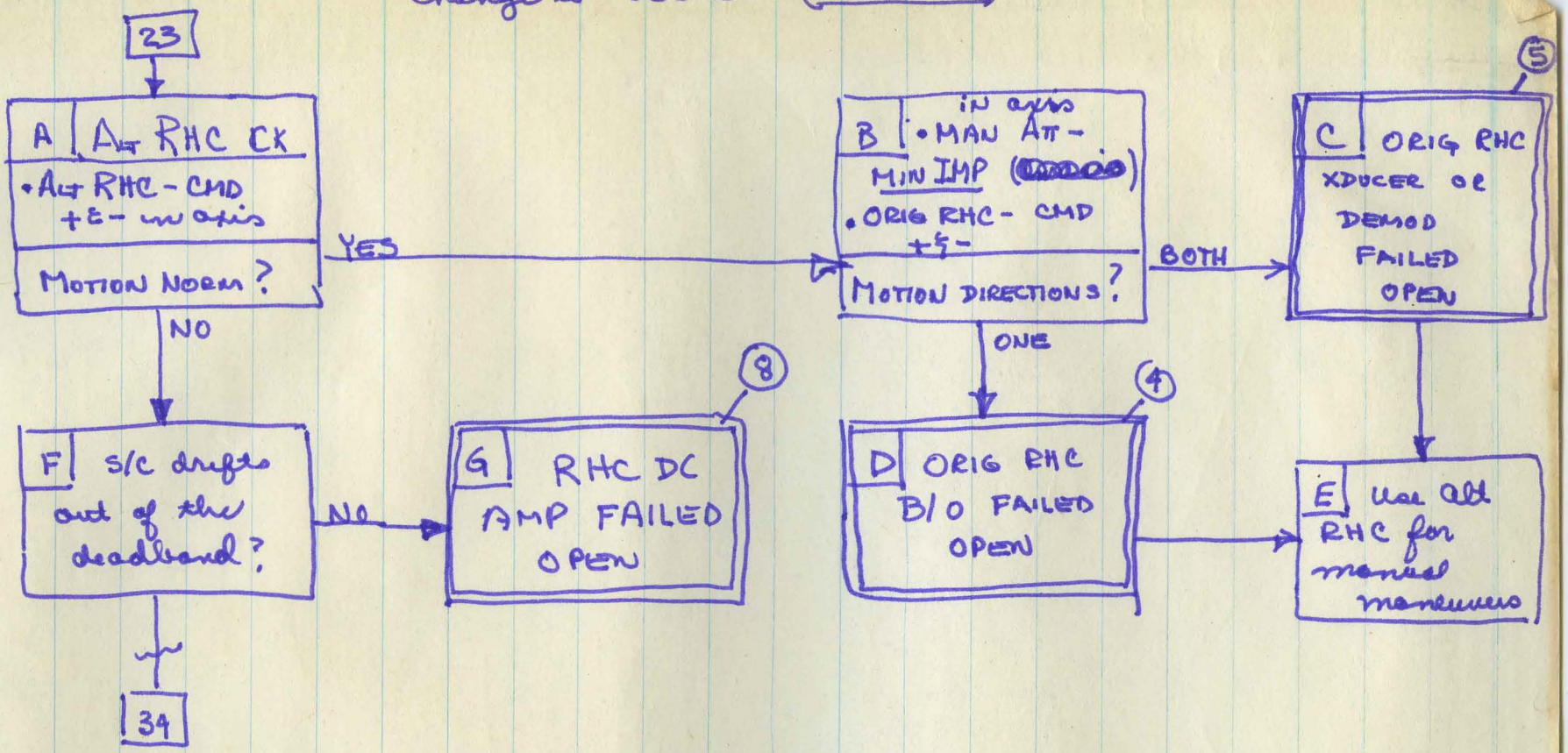


New Layout of SCS #3 (Rate Cmd pg 2)

notes will have to be renumbered to include the addition of notes from prev. page.

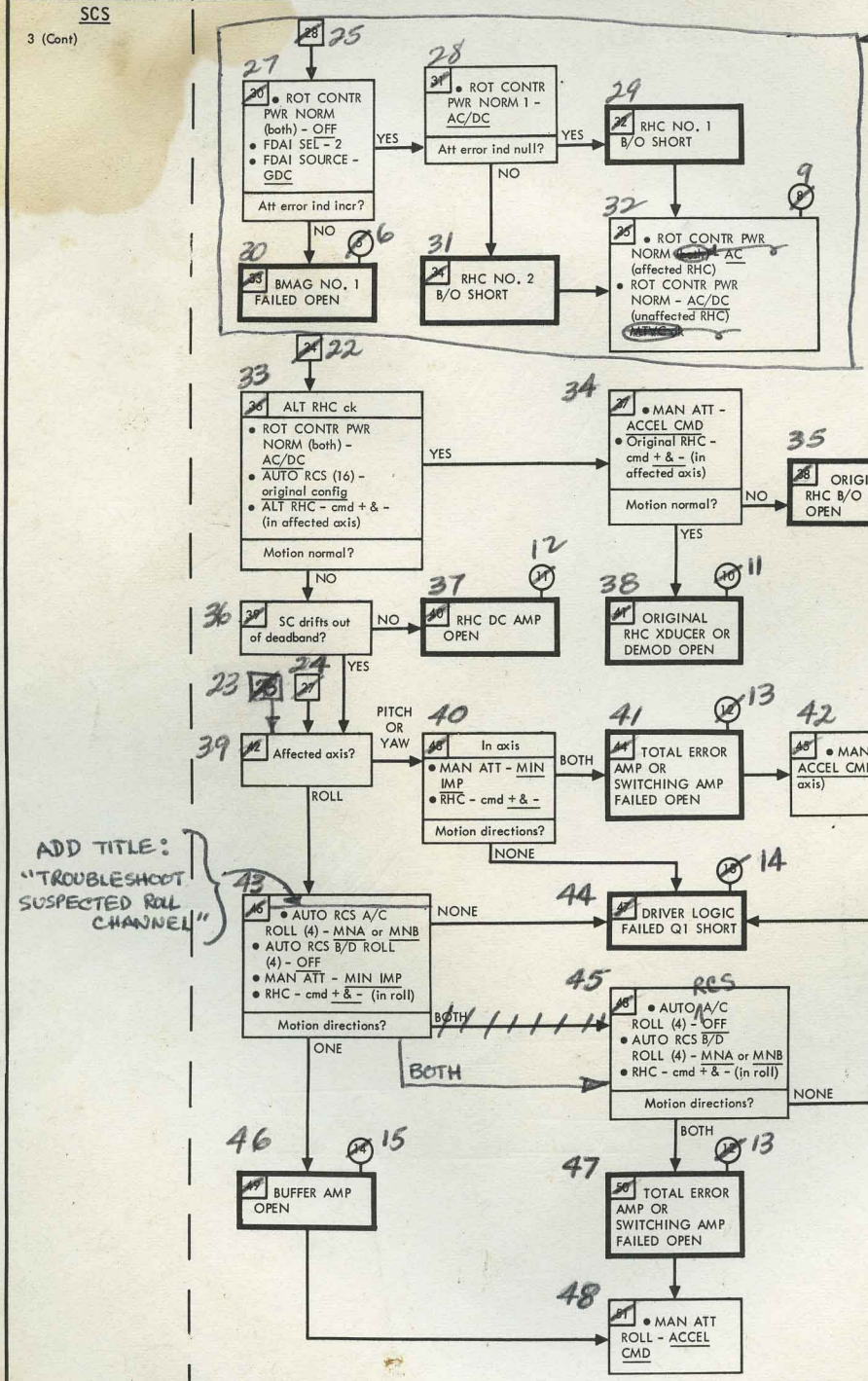
Change to SCS 3 (Rate CMD)



SYMPTOM	PROCEDURE	REMARKS

SCS

3 (Cont)



9 (8) DIRECT sws in affected RHC still functional. One RHC lost; however, RATE CMD mode in failed RHC still possible when breakout switches closed in same axis by operable RHC. MTVC OK WHEN ROT CONTR PWR NORM (AFFECTED RHC) IS AT AC. } ADDITION TO (9)

10 (9) Att hold unaffected but prop. cont, ACCEL CMD, MIN IMP, & CMC man cont lost for failed RHC. DIRECT unaffected but BMAG caging signal lost. AFFECTED RHC CAN BE USED FOR MTVC. } ADD

11 (10) SCS prop. cont & MTVC lost for failed RHC.

12 (11) SCS prop. cont & MTVC lost for both RHCs.

13 (12) All RATE CMD & att hold capability lost for affected axis. Translation possible with man att sw in RATE CMD & att cont in affected axis by DIRECT.

14 (13) Lose all SCS modes except ACCEL CMD. No translation on affected axis. DIRECT control available.

15 (14) One polarity lost in RATE CMD & MIN IMP. Translation capability remains but att hold lost.

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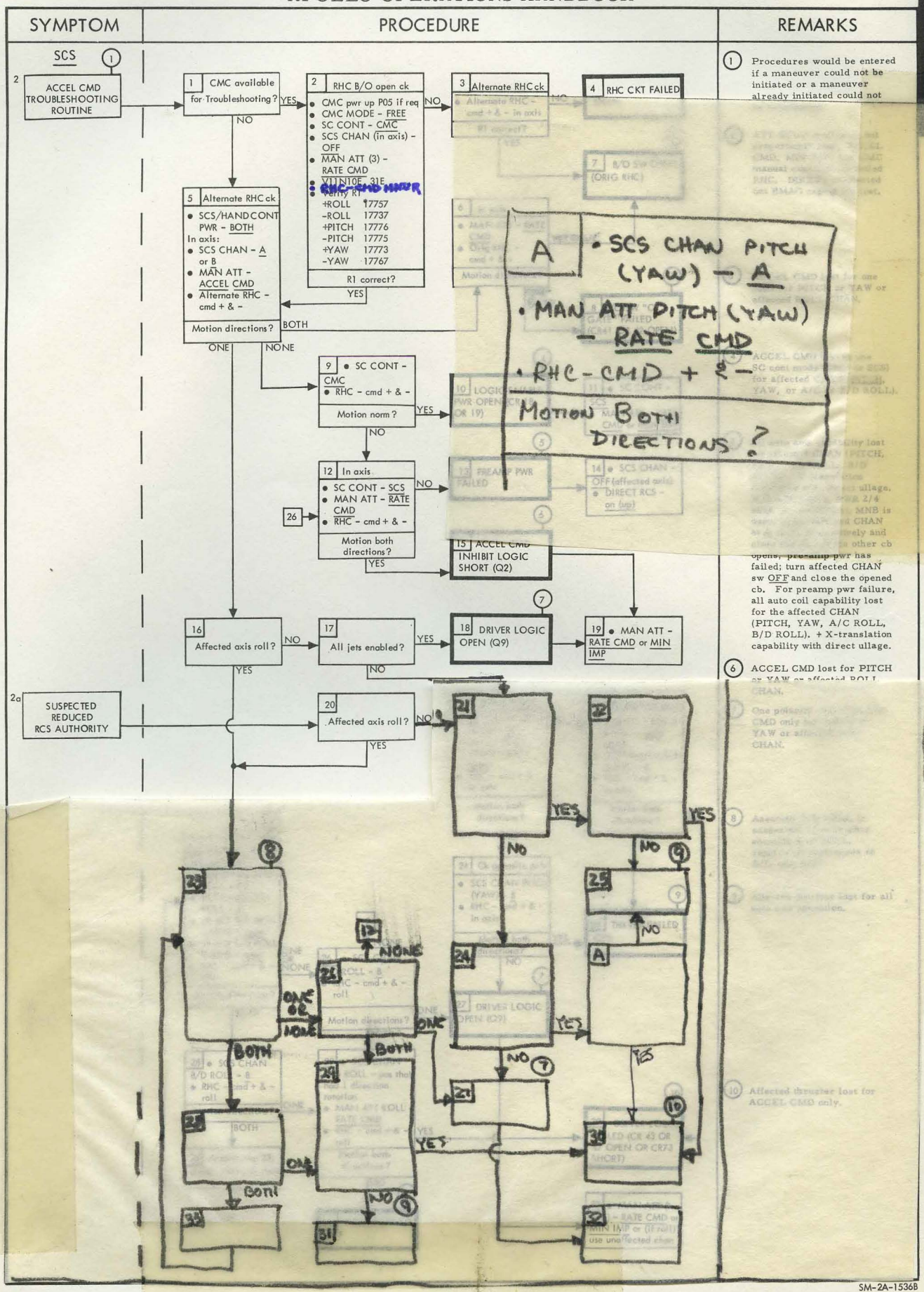
See Blake's redraw page



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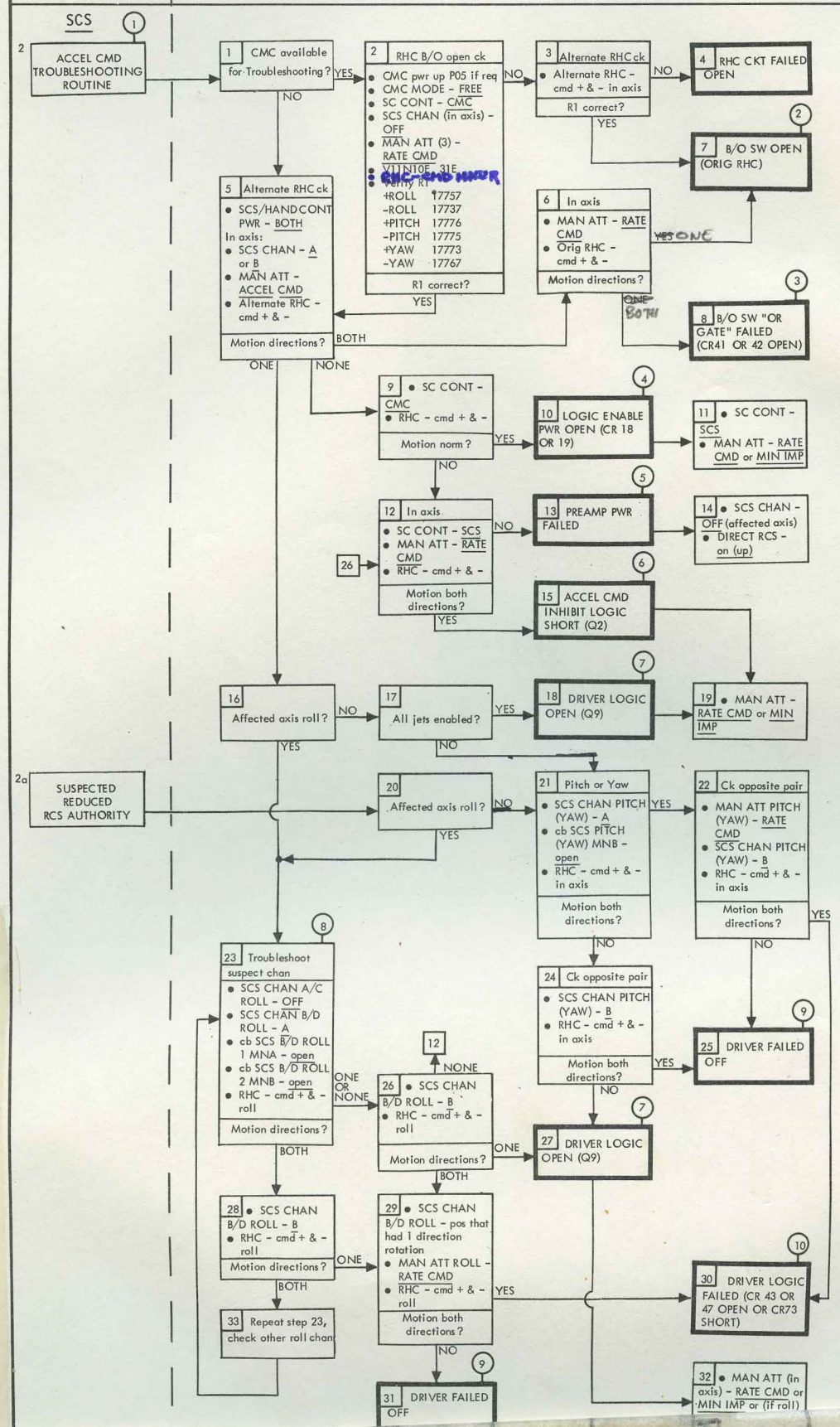
See Blake's redraw page

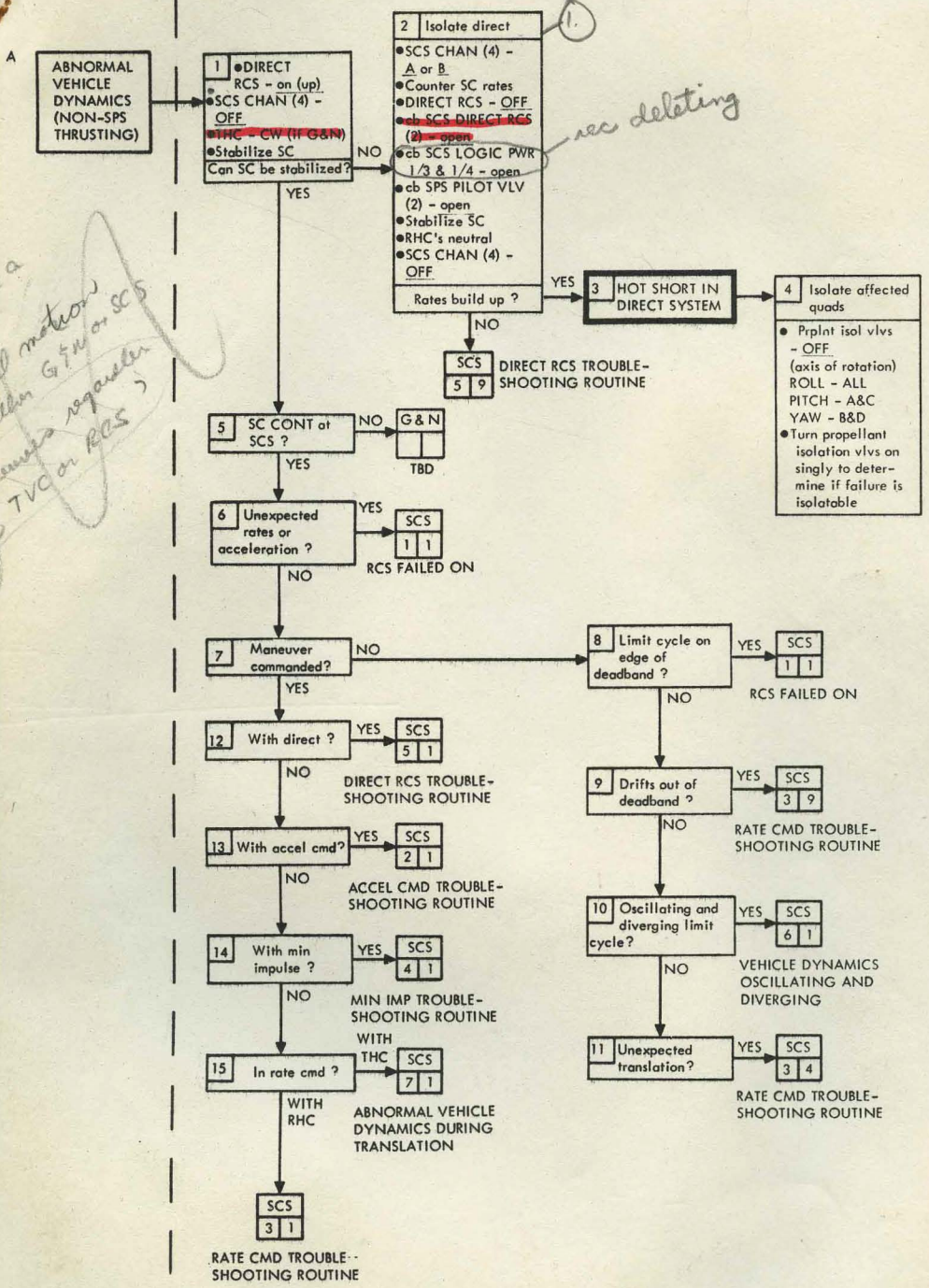
G&C MALFUNCTION

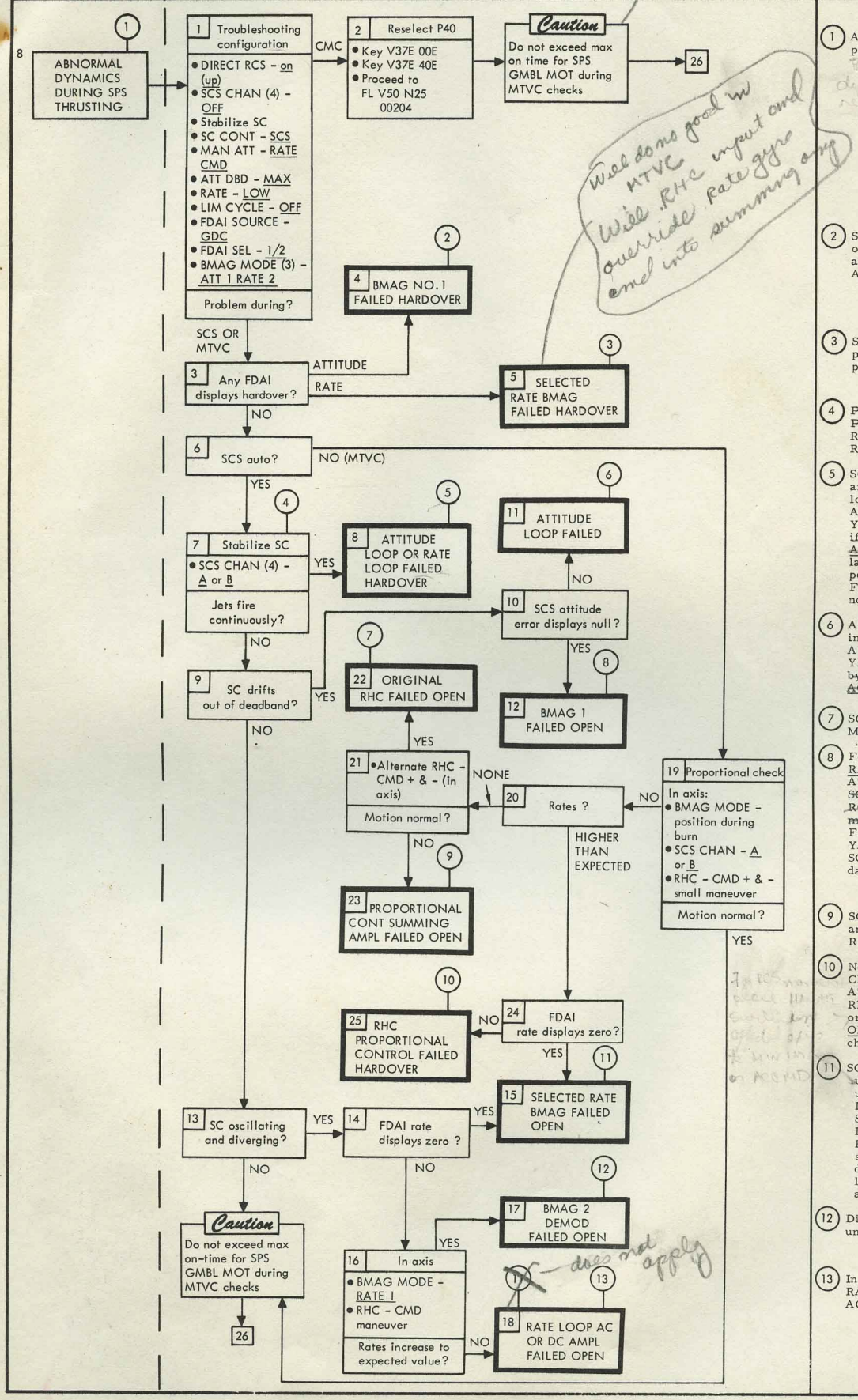
SYMPTOM	PROCEDURE	REMARKS



1. Procedures would be entered if a maneuver could not be initiated or a maneuver already initiated could not be terminated.
2. ATT HOLD unaffecte proportional cont, A CMD, MIN IMP, and manual cont lost for RHC. DIRECT unaff but BMAG caging sig
3. ACCEL CMD lost fo RHC for PITCH or affected ROLL CHA
4. ACCEL CMD lost in SC cont mode (CMC for affected CHAN (YAW, or A/C or B/
5. All auto coil capabi for affected CHAN YAW, A/C ROLL, ROLL). X-transla capability with dire If cb SCS LOGIC P MNA or cb ORDEA open, place affecte at A or B, respect close the cb. If th opens, pre-amp p failed; turn affected CHAN sw OFF and close the opened cb. For preamp pwr failure, all auto coil capability lost for the affected CHAN (PITCH, YAW, A/C ROLL, B/D ROLL). + X-translation capability with direct ullage.
6. ACCEL CMD lost for PITCH or YAW or affected ROLL CHAN.
7. One polarity lost in ACCEL CMD only for PITCH or YAW or affected ROLL CHAN.
8. Assumes B/D ROLL is suspected. For trouble shooting A/C ROLL, replace all references to B/D with A/C.
9. Affected thruster lost for all auto coil operation.
10. Affected thruster lost for ACCEL CMD only.

SYMPTOM	PROCEDURE	REMARKS

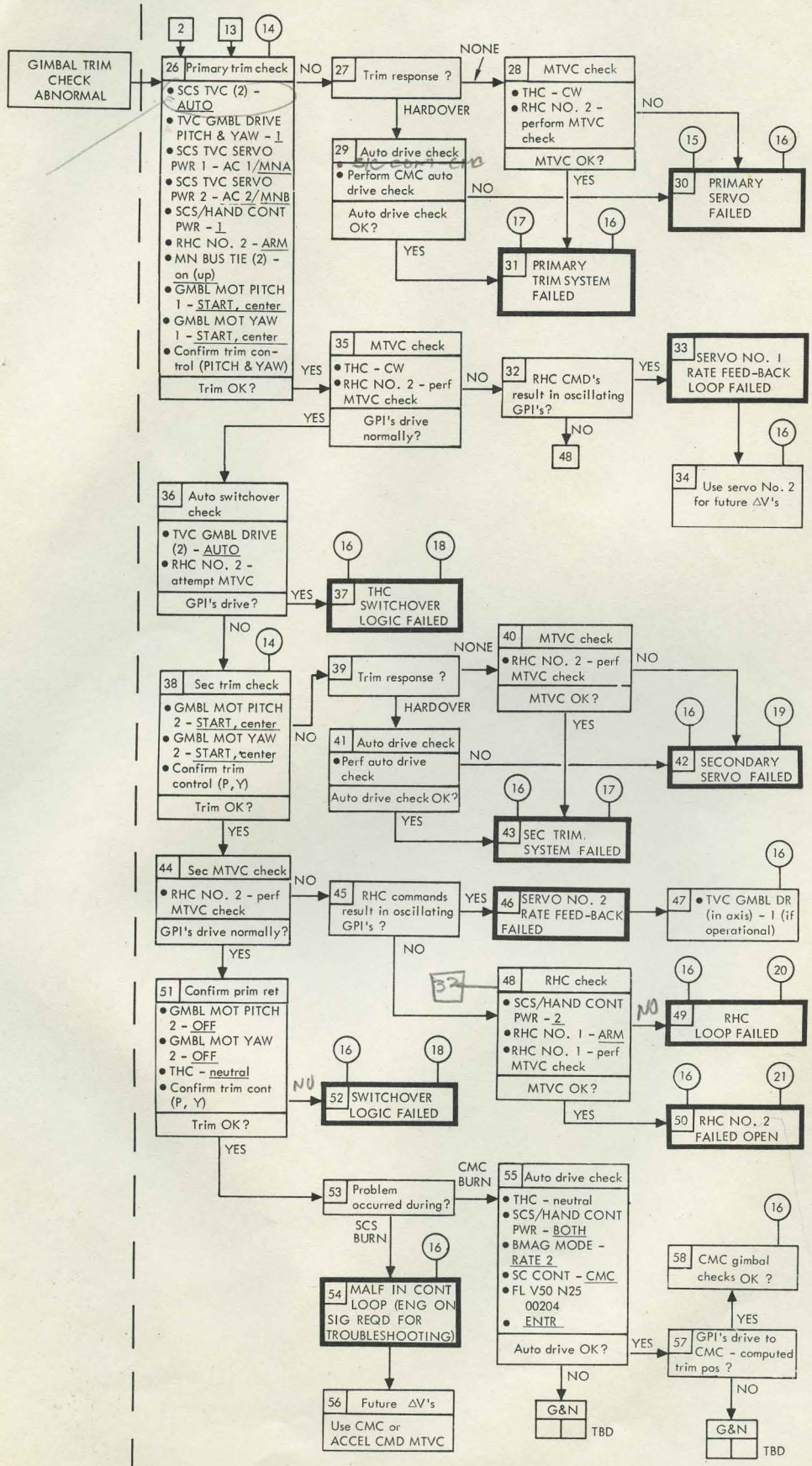



SYMPTOM
PROCEDURE
REMARKS
8
1 ABNORMAL DYNAMICS DURING SPS THRUSTING
1 Troubleshooting configuration
• DIRECT RCS - on (up)
• SCS CHAN (4) - OFF
• Stabilize SC
• SC CONT - SCS
• MAN ATT - RATE CMD
• ATT DBD - MAX
• RATE - LOW
• LIM CYCLE - OFF
• FDAI SOURCE - GDC
• FDAI SEL - 1/2
• BMAG MODE (3) - ATT 1 RATE 2
Problem during?
CMC
2 Reselect P40
• Key V37E 00E
• Key V37E 40E
• Proceed to FL V50 N25 00204
Caution
Do not exceed max on time for SPS GMBL MOT during MTVC checks
26
SCS OR MTVC
3 Any FDAI displays hardover?
ATTITUDE
RATE
NO
4 BMAG NO. 1 FAILED HARDOVER
5 SELECTED RATE BMAG FAILED HARDOVER
6 SCS auto?
NO (MTVC)
YES
7 Stabilize SC
• SCS CHAN (4) - A or B
Jets fire continuously?
YES
8 ATTITUDE LOOP OR RATE LOOP FAILED HARDOVER
NO
9 SC drifts out of deadband?
YES
22 ORIGINAL RHC FAILED OPEN
NO
10 SCS attitude error displays null?
YES
NO
11 ATTITUDE LOOP FAILED
12 BMAG 1 FAILED OPEN
21 •Alternate RHC - CMD + & - (in axis)
Motion normal?
NO
23 PROPORTIONAL CONT SUMMING AMPL FAILED OPEN
NONE
20 Rates ?
NO
HIGHER THAN EXPECTED
19 Proportional check
In axis:
• BMAG MODE - position during burn
• SCS CHAN - A or B
• RHC - CMD + & - small maneuver
Motion normal?
YES
25 RHC PROPORTIONAL CONTROL FAILED HARDOVER
NO
24 FDAI rate displays zero?
YES
15 SELECTED RATE BMAG FAILED OPEN
13 SC oscillating and diverging?
YES
14 FDAI rate displays zero ?
YES
NO
NO
Caution
Do not exceed max on-time for SPS GMBL MOT during MTVC checks
26
17 BMAG 2 DEMOD FAILED OPEN
YES
16 In axis
• BMAG MODE - RATE 1
• RHC - CMD maneuver
Rates increase to expected value?
NO
18 RATE LOOP AC OR DC AMPL FAILED OPEN
1 Assumes thrusting completed before troubleshooting.
2 SCS AUTO ΔV lost if PITCH or YAW. If ROLL, control attitude with DIRECT or ACCEL CMD.
3 SCS AUTO ΔV lost. MTVC possible if redundant BMAG placed in RATE position.
4 Procedure applicable to PITCH or YAW problem. For ROLL, refer to applicable RCS procedure.
5 SCS RATE CMD, ATT HOLD, and proportional control lost for affected axis. SCS AUTO ΔV lost if PITCH or YAW but operable in ROLL if channel switch placed at ACCEL CMD. Translations without ATT HOLD possible in MIN IMP. Further troubleshooting not recommended.
6 ATT HOLD capability lost in affected axis. SCS AUTO ΔV lost if PITCH or YAW, but possible if ROLL by placing MAN ATT ROLL - ACCEL CMD.
7 SCS proportional control & MTVC lost for failed RHC.
8 For affected axis: in ATT 1 RATE 2, ATT HOLD and ATT error display lost. SCS AUTO ΔV possible if ROLL by controlling attitude manually. After .05G, SCS FDAI roll att erroneous if YAW or ROLL. In RATE 1 SCS ball drive and rate damping lost.
9 SCS proportional control and MTVC lost for both RHC's.
10 No MTVC capability. RATE CMD lost in affected axis. ATT HOLD possible if RHC's locked (or neutral) or SCS/HAND CONT PWR - OFF. Disable affected channel if DIRECT used.
11 SCS ball drive lost in axis unless alternate rate BMAG used. If YAW or ROLL: If BMAG 1, after .05G SCS FDAI roll att erroneous. If BMAG 2, after .05G, RSI erroneous unless switched to RATE 1. Rate damping and SCS AUTO ΔV lost. For MTVC, use alternate rate BMAG.
12 Displays and RATE 1 unaffected.
13 In axis, rate damping lost. RATE CMD response like ACCEL CMD.

SWIGERT

G&C MALFUNCTION

SYMPTOM	PROCEDURE	REMARKS



(14) Start and stop gimbal ~~motion~~ motors sequentially at 1 sec intervals.

(15) Primary servo lost for all SPS ΔV's.

(16) GMBL MOT PITCH 1 - OFF
GMBL MOT YAW 1 - OFF
GMBL MOT PITCH 2 - OFF
GMBL MOT YAW 2 - OFF
SCS TVC SERVO PWR (2) - OFF

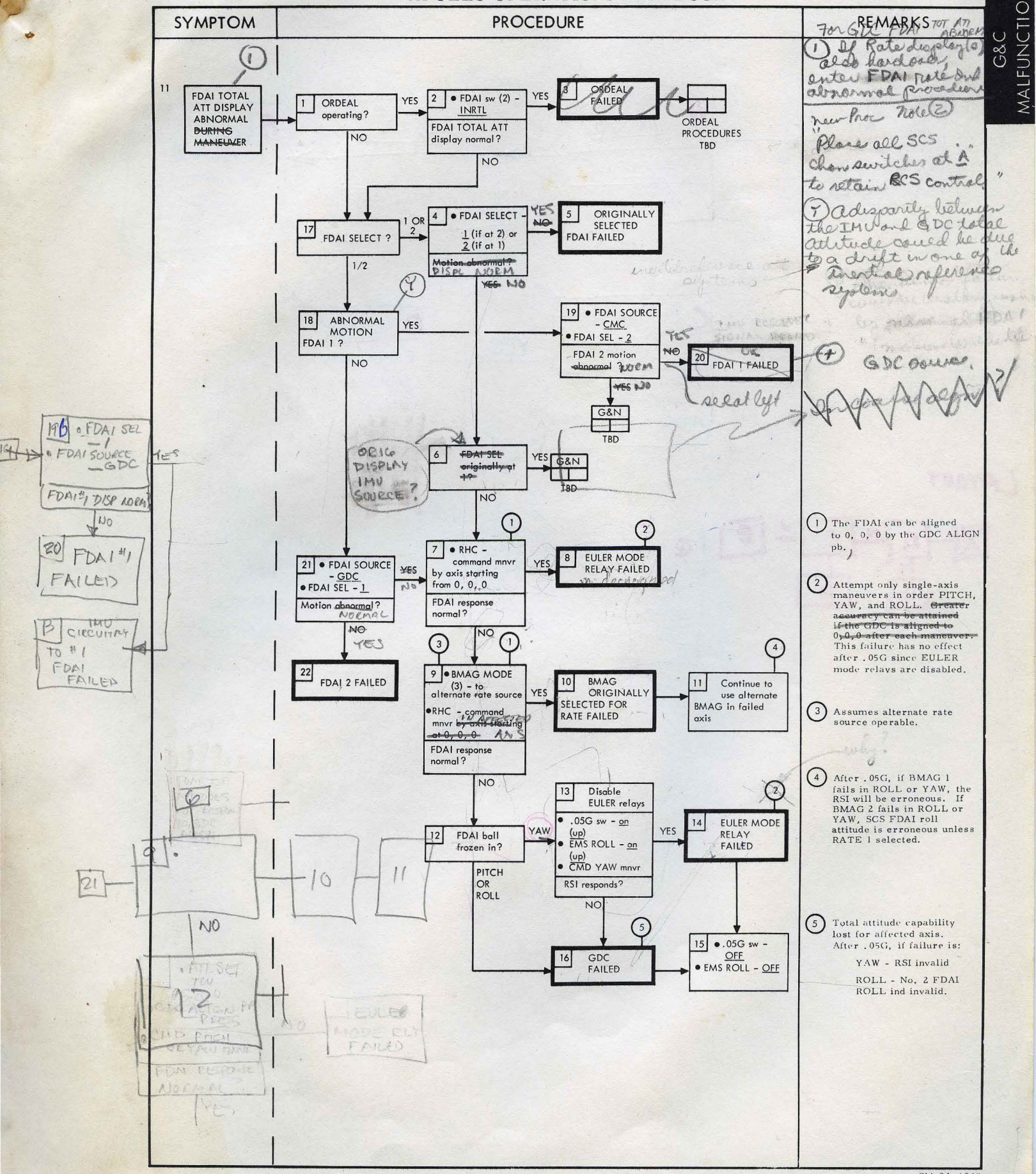
(17) CMC unaffected. On affected servo, SCS AUTO ΔV and TRIM lost, but MTVC without TRIM remains.

(18) Automatic switchover lost.

(19) Secondary servo lost for all SPS ΔV's.

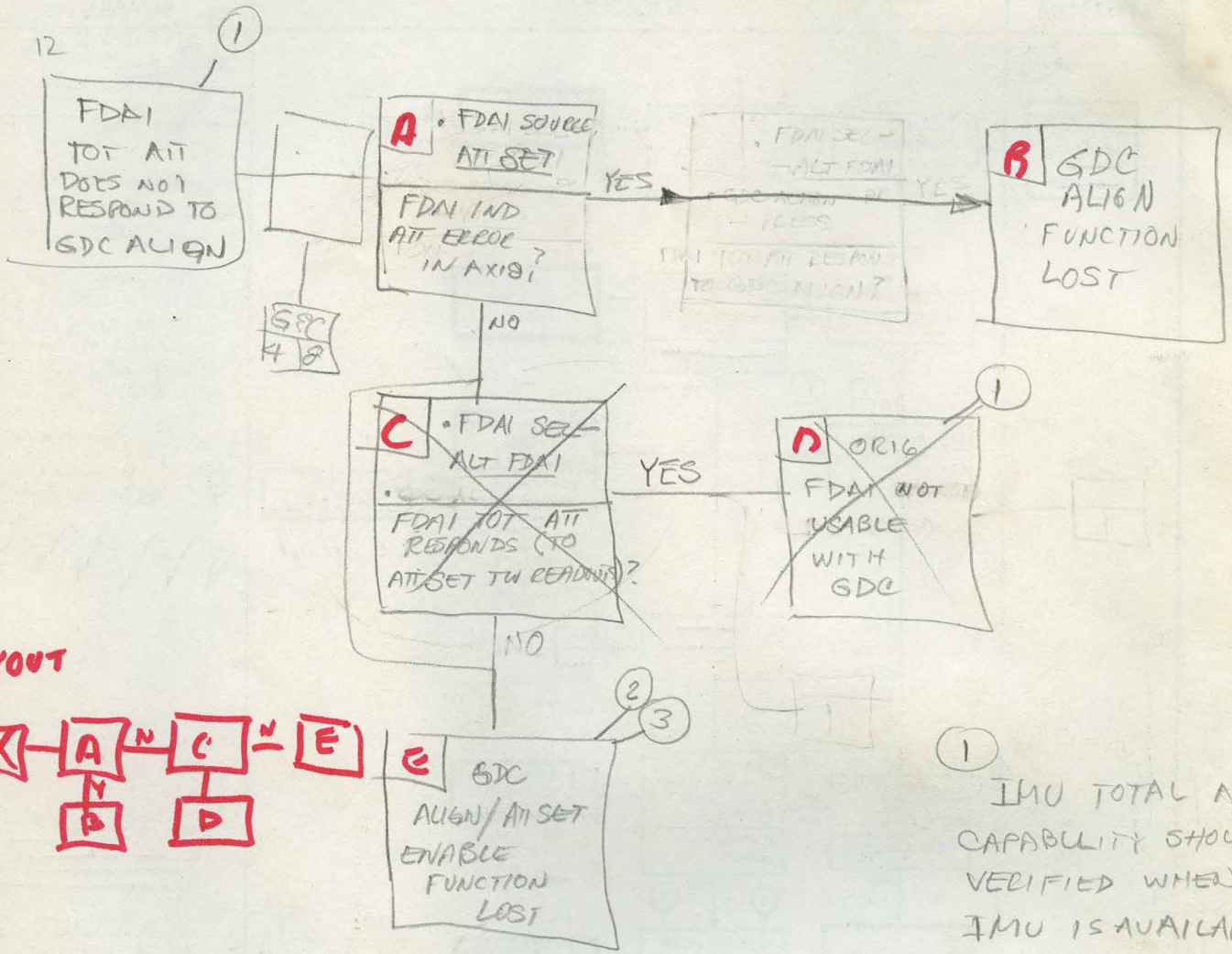
(20) All MTVC capability and proportional control lost. SCS AUTO ΔV and ATT HOLD unaffected.

(21) Proportional control and all MTVC capability lost for NO. 2 RHC.


SYMPTOM
PROCEDURE
REMARKS
FDAI TOTAL ATT DISPLAY ABNORMAL DURING MANEUVER
1 ORDEAL operating?
YES
NO
2 • FDAI sw (2) - INRTL
FDAI TOTAL ATT display normal?
3 ORDEAL FAILED
ORDEAL PROCEDURES TBD
17 FDAI SELECT ?
1 OR 2
1/2
4 • FDAI SELECT - 1 (if at 2) or 2 (if at 1)
Motion abnormal? DISPL NORM
5 ORIGINALLY SELECTED FDAI FAILED
18 ABNORMAL MOTION FDAI 1 ?
19 • FDAI SOURCE - CMC
• FDAI SEL - 2
FDAI 2 motion abnormal? NORM
20 FDAI 1 FAILED
G&N
TBD
6 FDAI SEL originally at 1?
ORIG DISPLAY IMU SOURCE?
21 • FDAI SOURCE - GDC
• FDAI SEL - 1
Motion abnormal? NORMAL
22 FDAI 2 FAILED
7 • RHC - command mnvr by axis starting from 0, 0, 0
FDAI response normal?
8 EULER MODE RELAY FAILED
9 • BMAG MODE (3) - to alternate rate source
• RHC - command mnvr by axis starting at 0, 0, 0
FDAI response normal?
10 BMAG ORIGINALLY SELECTED FOR RATE FAILED
11 Continue to use alternate BMAG in failed axis
12 FDAI ball frozen in?
PITCH OR ROLL
YAW
13 Disable EULER relays
• .05G sw - on (up)
• EMS ROLL - on (up)
• CMD YAW mnvr
RSI responds?
14 EULER MODE RELAY FAILED
15 • .05G sw - OFF
• EMS ROLL - OFF
16 GDC FAILED
1 The FDAI can be aligned to 0, 0, 0 by the GDC ALIGN pb.
2 Attempt only single-axis maneuvers in order PITCH, YAW, and ROLL. Greater accuracy can be attained if the GDC is aligned to 0,0,0 after each maneuver. This failure has no effect after .05G since EULER mode relays are disabled.
3 Assumes alternate rate source operable.
4 After .05G, if BMAG 1 fails in ROLL or YAW, the RSI will be erroneous. If BMAG 2 fails in ROLL or YAW, SCS FDAI roll attitude is erroneous unless RATE 1 selected.
5 Total attitude capability lost for affected axis. After .05G, if failure is:
YAW - RSI invalid
ROLL - No. 2 FDAI ROLL ind invalid.

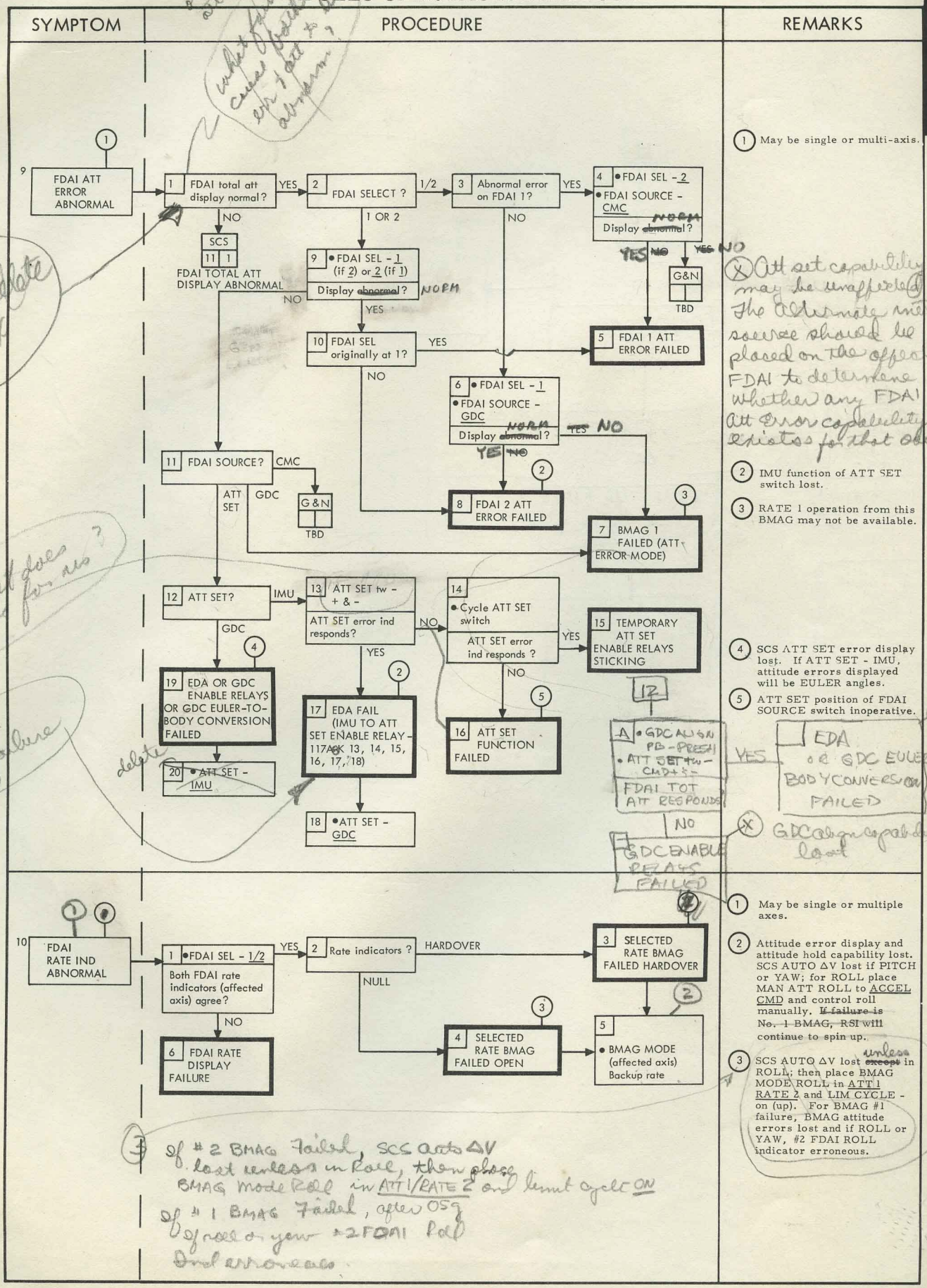
f2d11

12

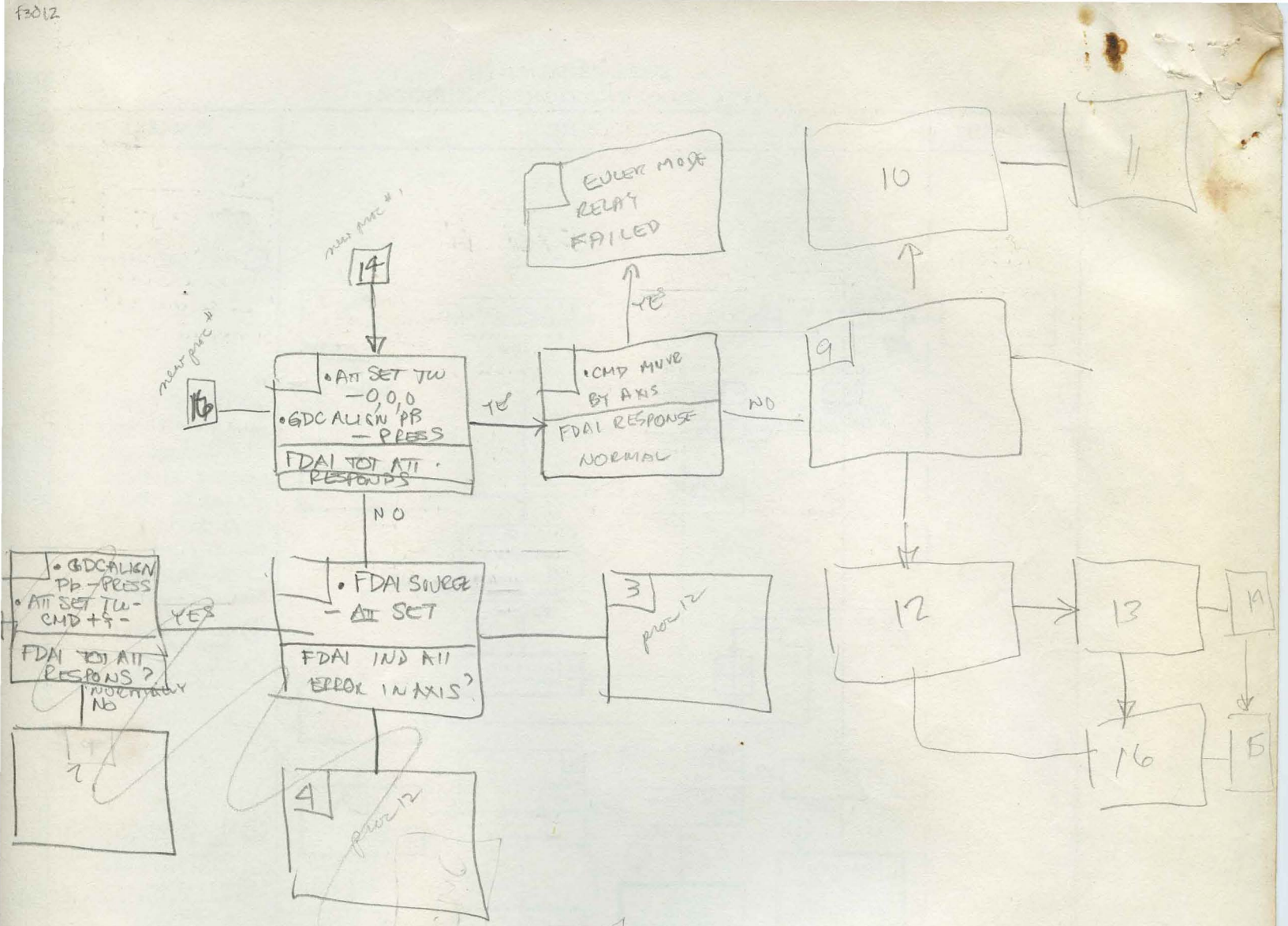


LAYOUT

(1) IMU TOTAL ATT CAPABILITY SHOULD BE VERIFIED WHEN THE IMU IS AVAILABLE.


SYMPTOM
PROCEDURE
REMARKS
9 FDAI ATT ERROR ABNORMAL
1 FDAI total att display normal?
YES
NO
2 FDAI SELECT ?
1/2
1 OR 2
3 Abnormal error on FDAI 1?
YES
NO
4 • FDAI SEL - 2
• FDAI SOURCE - CMC
Display abnormal?
NORM
YES
NO
G&N
TBD
SCS 11 1 FDAI TOTAL ATT DISPLAY ABNORMAL
9 • FDAI SEL - 1 (if 2) or 2 (if 1)
Display abnormal?
NORM
NO
YES
10 FDAI SEL originally at 1?
YES
NO
5 FDAI 1 ATT ERROR FAILED
6 • FDAI SEL - 1
• FDAI SOURCE - GDC
Display abnormal?
YES
NO
8 FDAI 2 ATT ERROR FAILED
11 FDAI SOURCE?
CMC
ATT SET
GDC
G&N
TBD
7 BMAG 1 FAILED (ATT ERROR MODE)
12 ATT SET?
IMU
GDC
13 ATT SET tw - + & -
ATT SET error ind responds?
NO
YES
14 • Cycle ATT SET switch
ATT SET error ind responds ?
YES
NO
15 TEMPORARY ATT SET ENABLE RELAYS STICKING
16 ATT SET FUNCTION FAILED
19 EDA OR GDC ENABLE RELAYS OR GDC EULER-TO-BODY CONVERSION FAILED
20 • ATT SET - IMU
17 EDA FAIL (IMU TO ATT SET ENABLE RELAY - 117A&K 13, 14, 15, 16, 17, 18)
18 • ATT SET - GDC
12
A • GDC ALIGN PB - PRESS
• ATT SET tw - CMD + & -
FDAI TOT ATT RESPONDS
YES
NO
EDA GDC EULER TO BODY CONVERSION FAILED
GDC ENABLE RELAYS FAILED
10 FDAI RATE IND ABNORMAL
1 • FDAI SEL - 1/2
Both FDAI rate indicators (affected axis) agree?
YES
NO
2 Rate indicators ?
HARDOVER
NULL
3 SELECTED RATE BMAG FAILED HARDOVER
4 SELECTED RATE BMAG FAILED OPEN
5 • BMAG MODE (affected axis) Backup rate
6 FDAI RATE DISPLAY FAILURE
1 May be single or multi-axis.
2 IMU function of ATT SET switch lost.
3 RATE 1 operation from this BMAG may not be available.
4 SCS ATT SET error display lost. If ATT SET - IMU, attitude errors displayed will be EULER angles.
5 ATT SET position of FDAI SOURCE switch inoperative.
1 May be single or multiple axes.
2 Attitude error display and attitude hold capability lost. SCS AUTO ΔV lost if PITCH or YAW; for ROLL place MAN ATT ROLL to ACCEL CMD and control roll manually. If failure is No. 1 BMAG, RSI will continue to spin up.
3 SCS AUTO ΔV lost unless in ROLL; then place BMAG MODE ROLL in ATT 1 RATE 2 and LIM CYCLE - on (up). For BMAG #1 failure, BMAG attitude errors lost and if ROLL or YAW, #2 FDAI ROLL indicator erroneous.

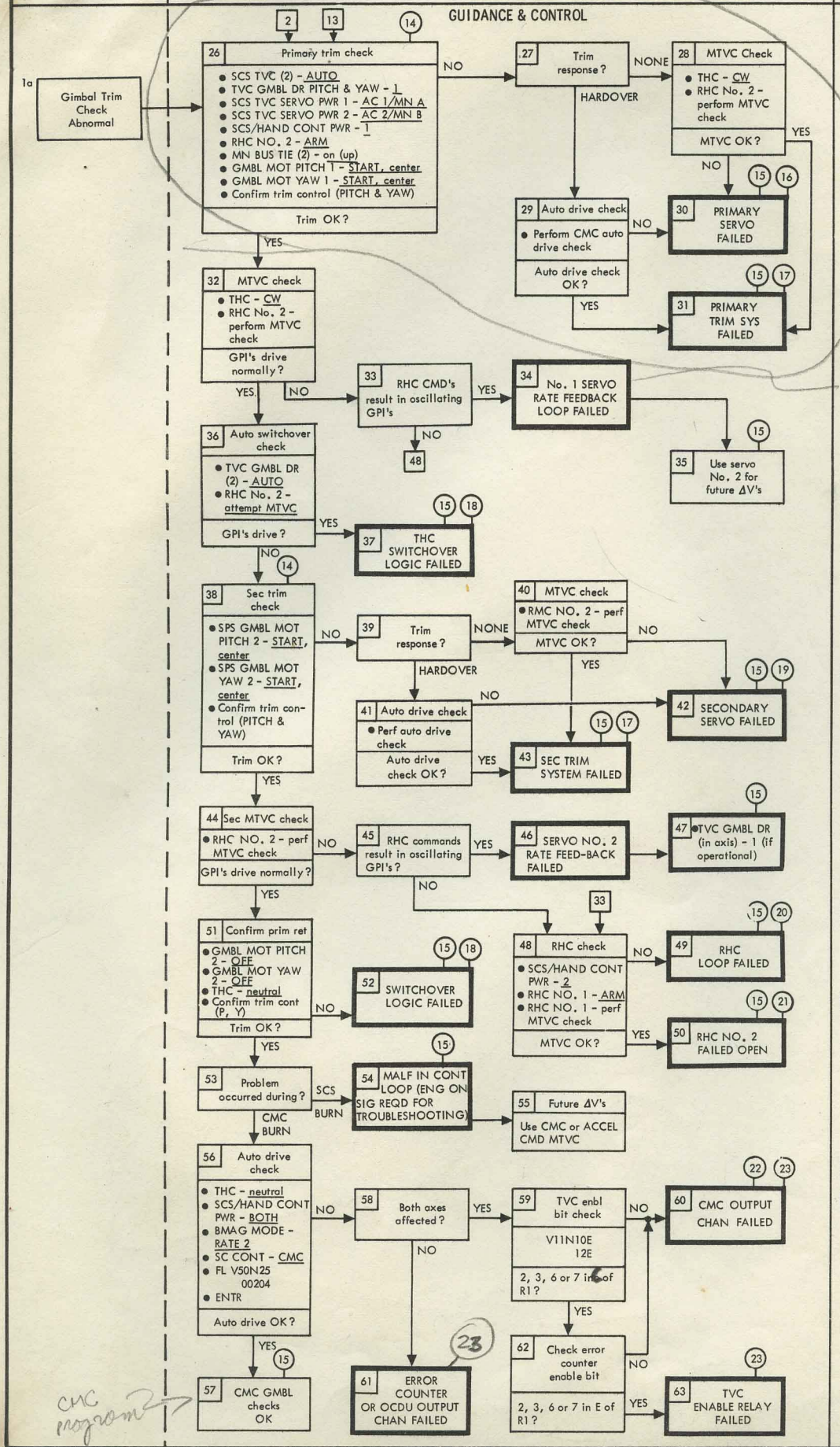
F3012


EULER MODE RELAY FAILED
10
11
14
next proc #
16
next proc #
• ATT SET TO −0,0,0
• GDC ALIGN PB − PRESS
FDAI TOT ATT RESPONDS
YES
• CMD MOVE BY AXIS
FDAI RESPONSE NORMAL
NO
9
NO
• GDC ALIGN PB − PRESS
• ATT SET TO − CMD + 5 −
FDAI TOT ATT RESPONS?
NORMALLY NO
YES
• FDAI SOURCE − ATT SET
FDAI IND ATT ERROR IN AXIS?
3
proc 12
12
13
14
15
16
2
4
proc 12

SWIGERT

G&C MALFUNCTION

SYMPTOM	PROCEDURE	REMARKS



(14) Start and stop gimbal motors sequentially at 1 second intervals.

(15) GMBL MOT PITCH 1 - OFF
GMBL MOT YAW 1 - OFF
GMBL MOT PITCH 2 - OFF
GMBL MOT YAW 2 - OFF
SCS TVC SERVO PWR (2) - OFF

(16) Primary servo lost for all SPS ΔV's.

(17) CMC unaffected. On affected servo, SCS AUTO ΔV and TRIM lost, but MTVC without TRIM remains.

will attempt CMC autodrive ok

(18) Automatic switchover lost.

(19) Secondary servo lost for all SPS ΔV's.

(20) All MTVC capability and proportional control lost. SCS AUTO ΔV and ATT HOLD unaffected.

(21) Proportional control and all MTVC capability lost for No. 2 RHC.

(22) Auto optics lost.

(23) CMC ΔV capability lost.

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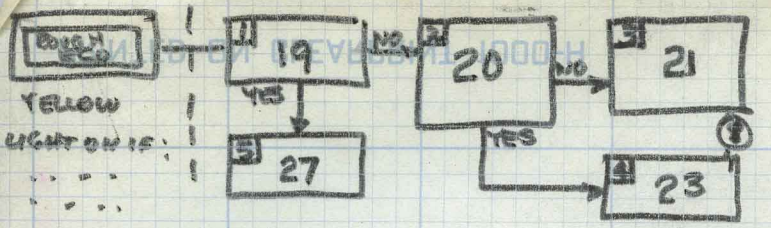
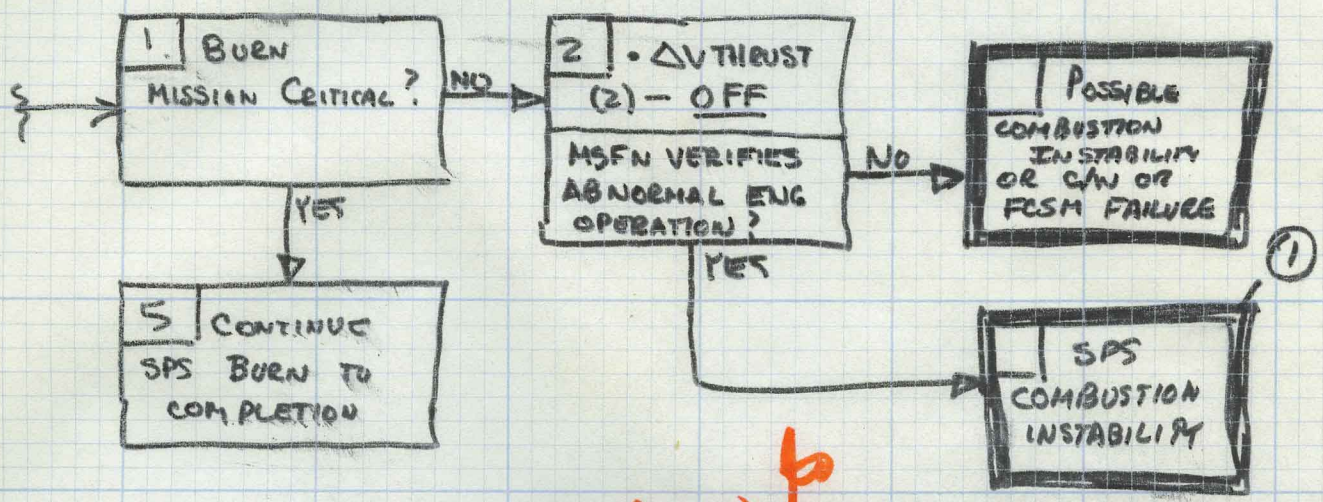
Basic Date _____ Change Date _____ Page _____

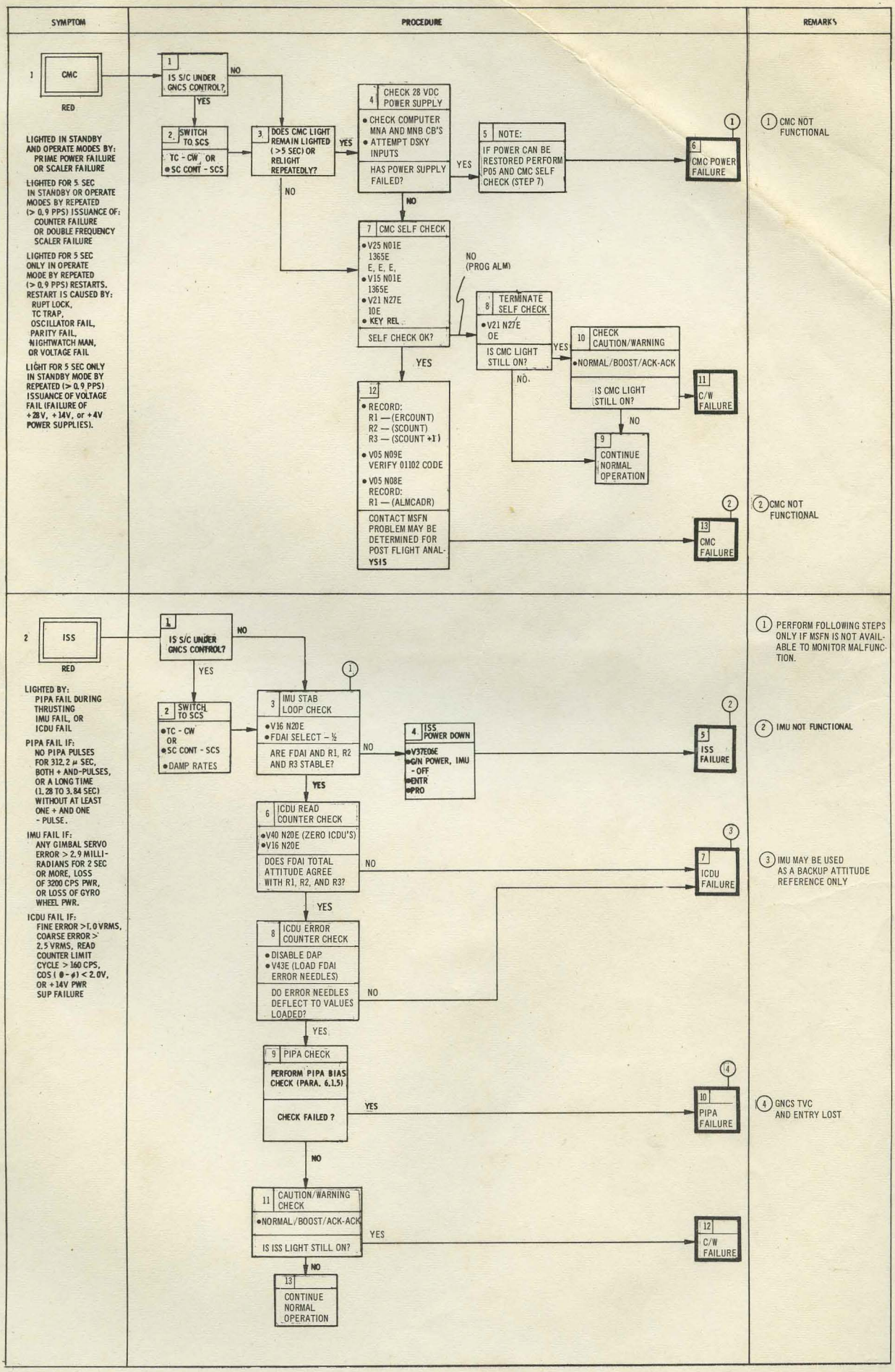
FORM 2997-E New 11-67

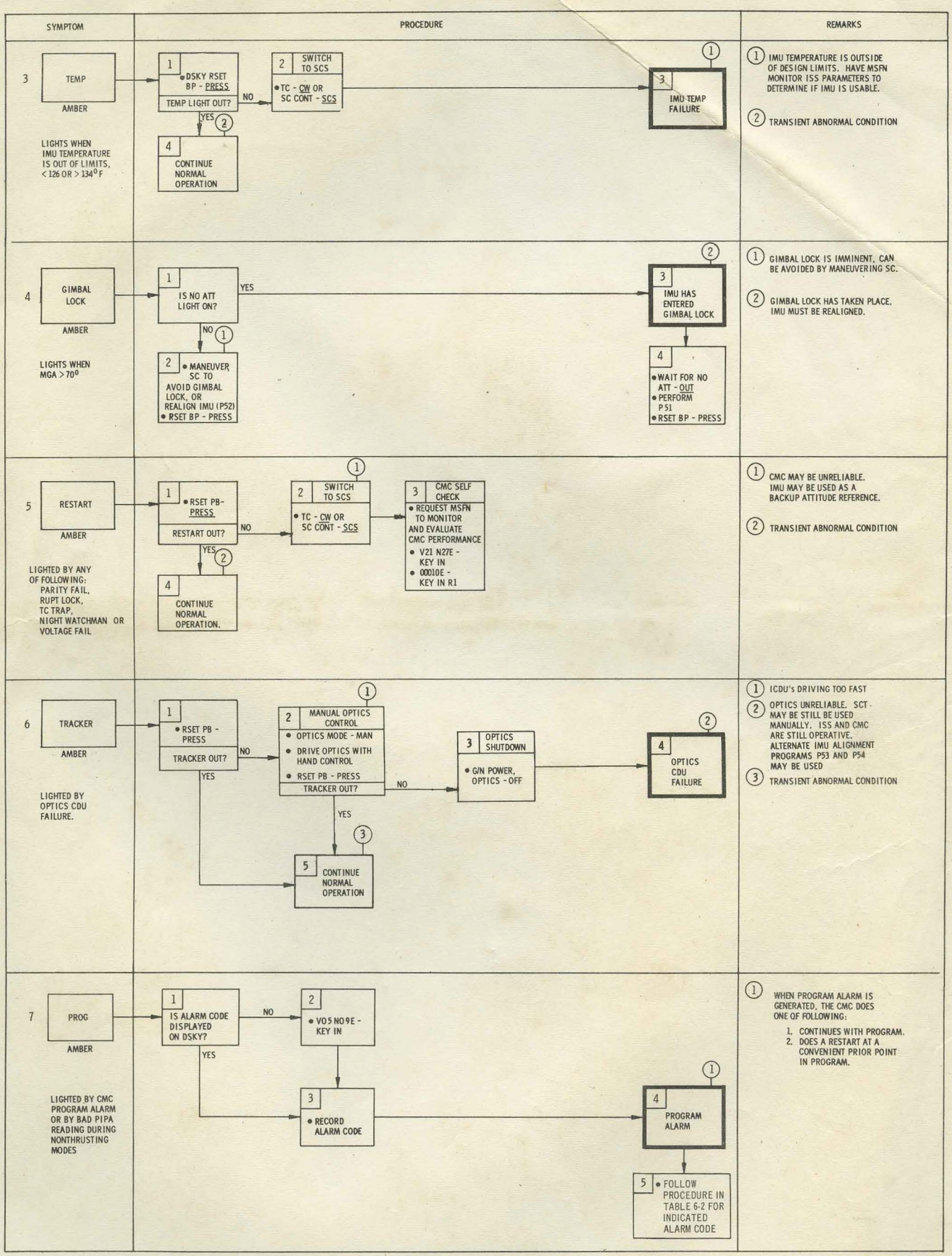




(1) SPS operability dependent upon subsequent investigation

This is page 2 of the SPS procedure if the FCSM mod is incorporated on S/C 101 21 Aug 68


SYMPTOM
PROCEDURE
REMARKS
1 CMC
RED
LIGHTED IN STANDBY AND OPERATE MODES BY: PRIME POWER FAILURE OR SCALER FAILURE
LIGHTED FOR 5 SEC IN STANDBY OR OPERATE MODES BY REPEATED (> 0.9 PPS) ISSUANCE OF: COUNTER FAILURE OR DOUBLE FREQUENCY SCALER FAILURE
LIGHTED FOR 5 SEC ONLY IN OPERATE MODE BY REPEATED (> 0.9 PPS) RESTARTS. RESTART IS CAUSED BY: RUPT LOCK, TC TRAP, OSCILLATOR FAIL, PARITY FAIL, NIGHTWATCH MAN, OR VOLTAGE FAIL
LIGHT FOR 5 SEC ONLY IN STANDBY MODE BY REPEATED (> 0.9 PPS) ISSUANCE OF VOLTAGE FAIL (FAILURE OF +28V, +14V, or +4V POWER SUPPLIES).
1 IS S/C UNDER GNCS CONTROL?
NO
YES
2 SWITCH TO SCS
TC - CW OR SC CONT - SCS
3 DOES CMC LIGHT REMAIN LIGHTED (>5 SEC) OR RELIGHT REPEATEDLY?
YES
NO
4 CHECK 28 VDC POWER SUPPLY
• CHECK COMPUTER MNA AND MNB CB'S
• ATTEMPT DSKY INPUTS
HAS POWER SUPPLY FAILED?
YES
NO
5 NOTE:
IF POWER CAN BE RESTORED PERFORM P05 AND CMC SELF CHECK (STEP 7)
1
6 CMC POWER FAILURE
7 CMC SELF CHECK
• V25 N01E 1365E E, E, E,
• V15 N01E 1365E
• V21 N27E 10E
• KEY REL
SELF CHECK OK?
NO (PROG ALM)
YES
8 TERMINATE SELF CHECK
• V21 N27E 0E
IS CMC LIGHT STILL ON?
YES
NO
10 CHECK CAUTION/WARNING
• NORMAL/BOOST/ACK-ACK
IS CMC LIGHT STILL ON?
YES
NO
11 C/W FAILURE
9 CONTINUE NORMAL OPERATION
12
• RECORD: R1 — (ERCOUNT) R2 — (SCOUNT) R3 — (SCOUNT +1)
• V05 N09E VERIFY 01102 CODE
• V05 N08E RECORD: R1 — (ALMCADR)
CONTACT MSFN PROBLEM MAY BE DETERMINED FOR POST FLIGHT ANALYSIS
2
13 CMC FAILURE
1 CMC NOT FUNCTIONAL
2 CMC NOT FUNCTIONAL
2 ISS
RED
LIGHTED BY: PIPA FAIL DURING THRUSTING IMU FAIL, OR ICDU FAIL
PIPA FAIL IF: NO PIPA PULSES FOR 312.2 μ SEC, BOTH + AND - PULSES, OR A LONG TIME (1.28 TO 3.84 SEC) WITHOUT AT LEAST ONE + AND ONE - PULSE.
IMU FAIL IF: ANY GIMBAL SERVO ERROR > 2.9 MILLI-RADIANS FOR 2 SEC OR MORE, LOSS OF 3200 CPS PWR, OR LOSS OF GYRO WHEEL PWR.
ICDU FAIL IF: FINE ERROR > 1.0 VRMS, COARSE ERROR > 2.5 VRMS, READ COUNTER LIMIT CYCLE > 160 CPS, COS (θ - φ) < 2.0V, OR +14V PWR SUP FAILURE
1 IS S/C UNDER GNCS CONTROL?
NO
YES
2 SWITCH TO SCS
• TC - CW OR • SC CONT - SCS
• DAMP RATES
1
3 IMU STAB LOOP CHECK
• V16 N20E
• FDAI SELECT – ½
ARE FDAI AND R1, R2 AND R3 STABLE?
NO
YES
4 ISS POWER DOWN
• V37E00E
• G/N POWER, IMU - OFF
• ENTR
• PRO
2
5 ISS FAILURE
6 ICDU READ COUNTER CHECK
• V40 N20E (ZERO ICDU'S)
• V16 N20E
DOES FDAI TOTAL ATTITUDE AGREE WITH R1, R2, AND R3?
NO
YES
3
7 ICDU FAILURE
8 ICDU ERROR COUNTER CHECK
• DISABLE DAP
• V43E (LOAD FDAI ERROR NEEDLES)
DO ERROR NEEDLES DEFLECT TO VALUES LOADED?
NO
YES
9 PIPA CHECK
PERFORM PIPA BIAS CHECK (PARA. 6.1.5)
CHECK FAILED ?
YES
NO
4
10 PIPA FAILURE
11 CAUTION/WARNING CHECK
• NORMAL/BOOST/ACK-ACK
IS ISS LIGHT STILL ON?
YES
NO
12 C/W FAILURE
13 CONTINUE NORMAL OPERATION
1 PERFORM FOLLOWING STEPS ONLY IF MSFN IS NOT AVAILABLE TO MONITOR MALFUNCTION.
2 IMU NOT FUNCTIONAL
3 IMU MAY BE USED AS A BACKUP ATTITUDE REFERENCE ONLY
4 GNCS TVC AND ENTRY LOST


SYMPTOM
PROCEDURE
REMARKS
3
TEMP
AMBER
LIGHTS WHEN IMU TEMPERATURE IS OUT OF LIMITS, < 126 OR > 134° F
1 • DSKY RSET BP - PRESS
TEMP LIGHT OUT?
NO
YES
2 SWITCH TO SCS
• TC - CW OR SC CONT - SCS
3 IMU TEMP FAILURE
4 CONTINUE NORMAL OPERATION
1 IMU TEMPERATURE IS OUTSIDE OF DESIGN LIMITS. HAVE MSFN MONITOR ISS PARAMETERS TO DETERMINE IF IMU IS USABLE.
2 TRANSIENT ABNORMAL CONDITION
4
GIMBAL LOCK
AMBER
LIGHTS WHEN MGA > 70°
1 IS NO ATT LIGHT ON?
YES
NO
2 • MANEUVER SC TO AVOID GIMBAL LOCK, OR REALIGN IMU (P52) • RSET BP - PRESS
3 IMU HAS ENTERED GIMBAL LOCK
4 • WAIT FOR NO ATT - OUT • PERFORM P51 • RSET BP - PRESS
1 GIMBAL LOCK IS IMMINENT, CAN BE AVOIDED BY MANEUVERING SC.
2 GIMBAL LOCK HAS TAKEN PLACE. IMU MUST BE REALIGNED.
5
RESTART
AMBER
LIGHTED BY ANY OF FOLLOWING: PARITY FAIL, RUPT LOCK, TC TRAP, NIGHT WATCHMAN OR VOLTAGE FAIL
1 • RSET PB - PRESS
RESTART OUT?
NO
YES
2 SWITCH TO SCS
• TC - CW OR SC CONT - SCS
3 CMC SELF CHECK
• REQUEST MSFN TO MONITOR AND EVALUATE CMC PERFORMANCE
• V21 N27E - KEY IN
• 00010E - KEY IN R1
4 CONTINUE NORMAL OPERATION.
1 CMC MAY BE UNRELIABLE. IMU MAY BE USED AS A BACKUP ATTITUDE REFERENCE.
2 TRANSIENT ABNORMAL CONDITION
6
TRACKER
AMBER
LIGHTED BY OPTICS CDU FAILURE.
1 • RSET PB - PRESS
TRACKER OUT?
NO
YES
2 MANUAL OPTICS CONTROL
• OPTICS MODE - MAN
• DRIVE OPTICS WITH HAND CONTROL
• RSET PB - PRESS
TRACKER OUT?
NO
YES
3 OPTICS SHUTDOWN
• G/N POWER, OPTICS - OFF
4 OPTICS CDU FAILURE
5 CONTINUE NORMAL OPERATION
1 ICDU's DRIVING TOO FAST
2 OPTICS UNRELIABLE. SCT MAY BE STILL BE USED MANUALLY. ISS AND CMC ARE STILL OPERATIVE. ALTERNATE IMU ALIGNMENT PROGRAMS P53 AND P54 MAY BE USED
3 TRANSIENT ABNORMAL CONDITION
7
PROG
AMBER
LIGHTED BY CMC PROGRAM ALARM OR BY BAD PIPA READING DURING NONTHRUSTING MODES
1 IS ALARM CODE DISPLAYED ON DSKY?
NO
YES
2 • V05 N09E - KEY IN
3 • RECORD ALARM CODE
4 PROGRAM ALARM
5 • FOLLOW PROCEDURE IN TABLE 6-2 FOR INDICATED ALARM CODE
1 WHEN PROGRAM ALARM IS GENERATED, THE CMC DOES ONE OF FOLLOWING:
1. CONTINUES WITH PROGRAM.
2. DOES A RESTART AT A CONVENIENT PRIOR POINT IN PROGRAM.

From Frank Mussetto 8/19/68 comments for TVC proc (G&C #1)

COMMENTS TO G&C PROCEDURES FOR 101/103

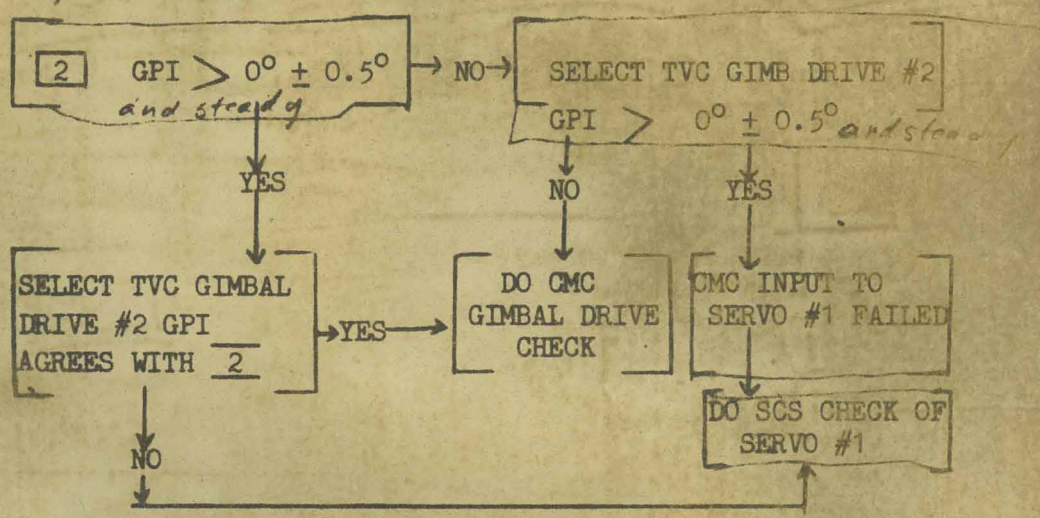
STEP 1: SHOULD ~~GPI~~ TURN CHANNEL SWITCHES OFF ONLY IN AFFECTED AXIS. SHOULD EXIT ONLY ON SCS OR G&N CONTROL; NO MTVC.

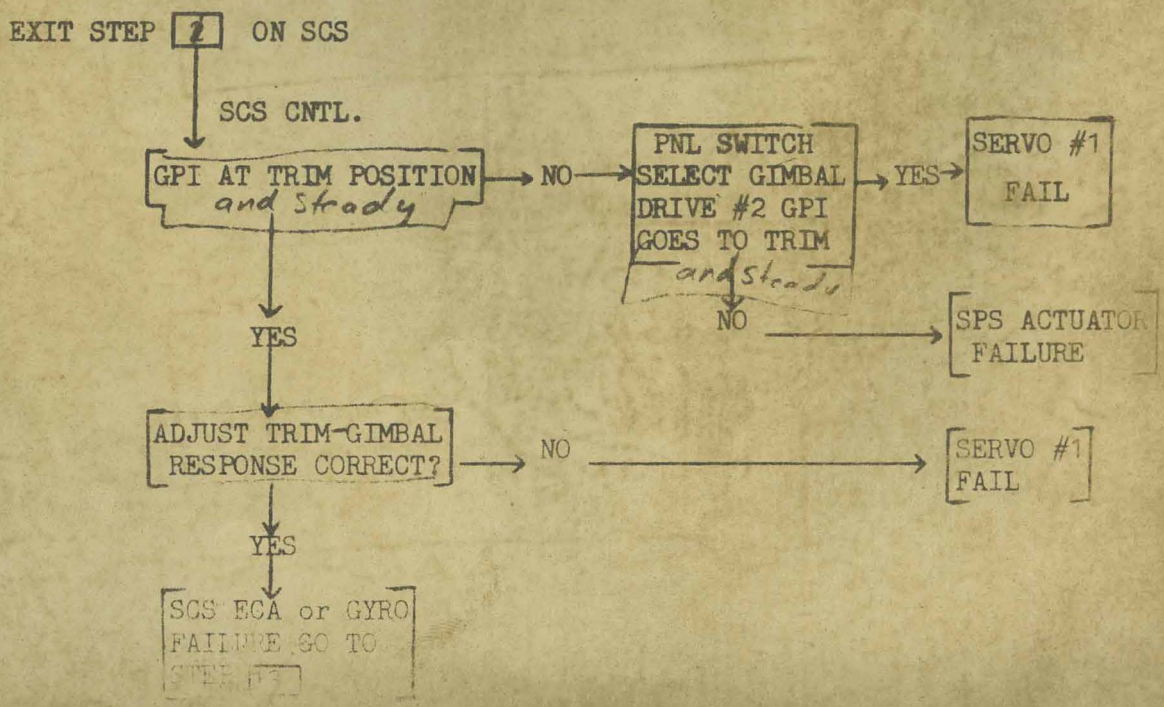
STEP 2: FOR THE GPI TO GO TO ZERO AFTER SHUTDOWN, THE FOLLOWING MUST HAVE OCCURRED:

1. CMC SHUT THE BURN OFF
2. CREW SHUT THE BURN OFF THEN EXITED PROGRAM

OTHERWISE THE ERROR COUNTER WILL NOT BE ZEROED AND THE TVC ENABLE WILL NOT BE RESET.

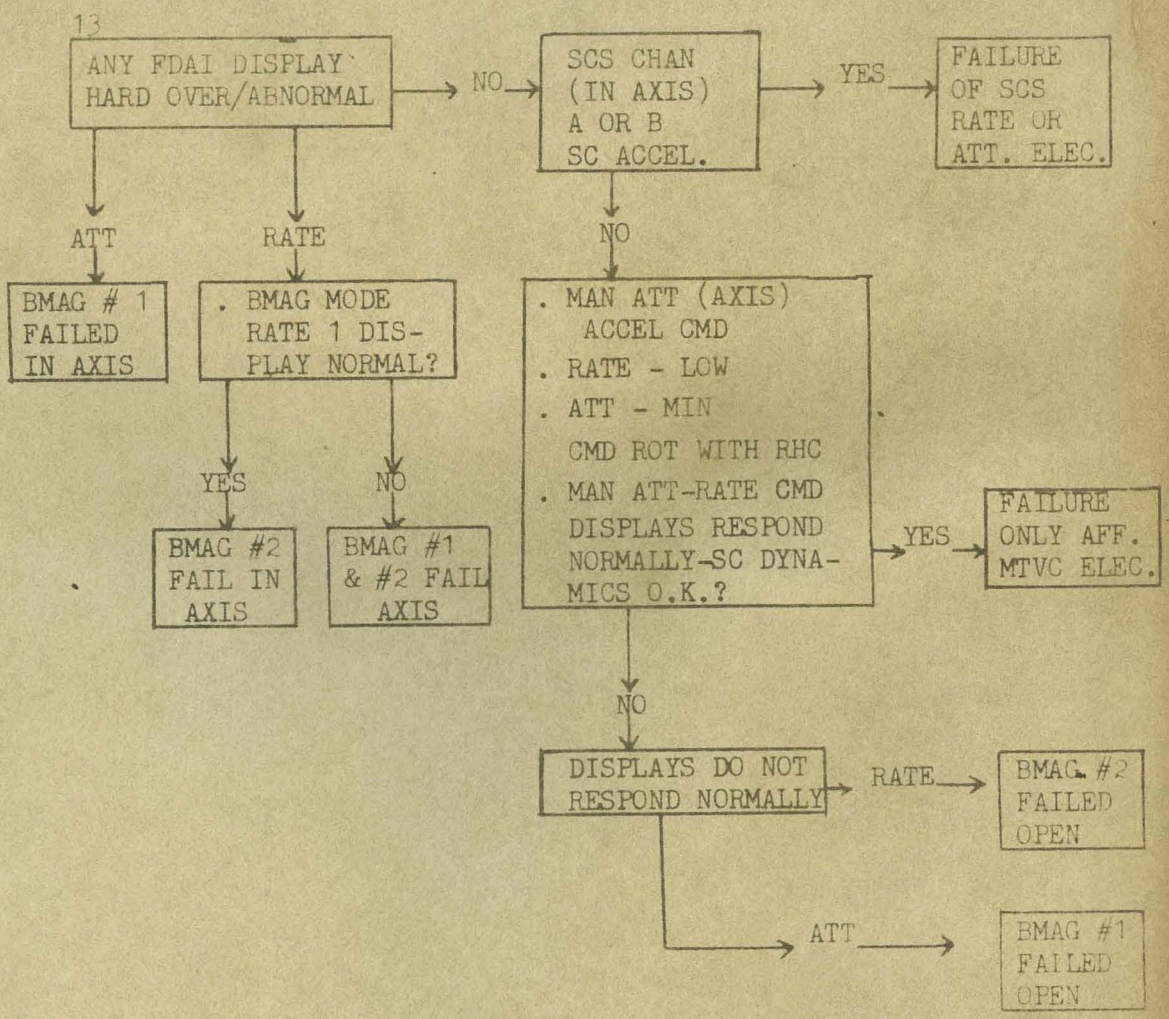
ACTION: REWRITE THIS STEP AS FOLLOWS. ASSUME; CMC DID NOT TURN ENGINE OFF, NO CMC OR ISS ALARMS.





[illegible]: THE ONLY TRANSFERABLE PROBLEM, BETWEEN SCS AUTO AND MTVC RATE, IS A RATE GYRO FAILURE, WHICH CAN ONLY BE DETECTED AFTER ENGINE IGNITION. SINCE, PROCEDURALLY THE ENGINE WOULD BE SHUT DOWN AFTER A FAILURE AND NOT RELIGHTED, THE FAILURE RELATIONSHIP STATED IN [illegible] DOES NOT EXIST.

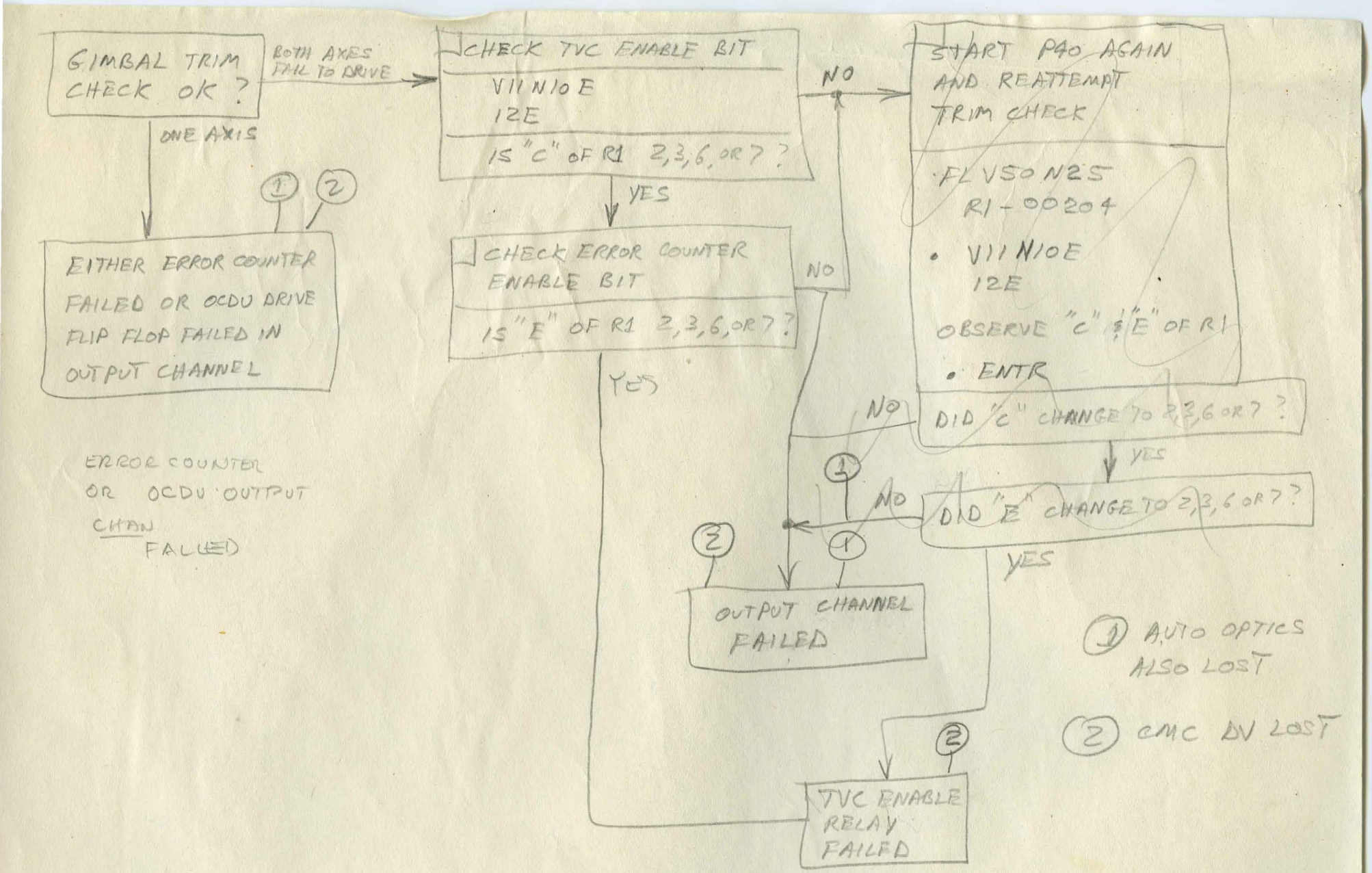
[13] SHOULD BE CHANGED AS FOLLOWS:



G&C

- 1 FDAI RATE IND. ABNORMAL

Should select [illegible] the display.


GIMBAL TRIM CHECK OK ?
BOTH AXES FAIL TO DRIVE
ONE AXIS
CHECK TVC ENABLE BIT
V11N10E
12E
IS "C" OF R1 2,3,6, OR 7 ?
NO
YES
START P40 AGAIN AND REATTEMPT TRIM CHECK
FLVS0N25
R1 - 00204
• V11N10E
12E
OBSERVE "C" & "E" OF R1
• ENTR
CHECK ERROR COUNTER ENABLE BIT
IS "E" OF R1 2,3,6,OR7 ?
NO
YES
DID "C" CHANGE TO 2,3,6 OR 7 ?
NO
YES
DID "E" CHANGE TO 2,3,6 OR 7 ?
NO
YES
1
2
EITHER ERROR COUNTER FAILED OR OCDU DRIVE FLIP FLOP FAILED IN OUTPUT CHANNEL
OUTPUT CHANNEL FAILED
TVC ENABLE RELAY FAILED
ERROR COUNTER OR OCDU OUTPUT CHAN FAILED
1 AUTO OPTICS ALSO LOST
2 CMC DV LOST

SYMPTON | PROCEDURE | REMARKS

CMC

Lighted by:

1 Switch to SCS
- THC - CW
or
- SC CONT - SCS

2 Does CMC light remain lighted (> 5 sec) or relight repeatedly?

YES

3 Check 28 vdc power supply
- Check COMPUTER MNA & MNB CB's
- Attempt DSKY inputs

Pwr supply failed?

YES

4 NOTE: If power can be restored, perform POS and CMC self check (Step 6)

5 CMC Power Fail

(1)

NO

6 CMC Self Check
- V25 N01 E
  1365 E
  E, E, E
- V15 N01 E
  1365 E
- V21 N27 E
  10 E
  KEY RLSE

Self Check OK?

YES (R2 becomes 5 or greater)

NO (PROG ALARM)

7 Terminate Self Check
V34E
CMC light still on?

YES

9 Check Caution/Warning
NORMAL/BOOST/ACK - ACK
CMC light still on?

YES

10 C/W Failure

NO

NO

8 Continue Normal Operation

11
- Record:
  R1 _____ (ERCOUNT)
  R2 _____ (SCOUNT)
  R3 _____ (SCOUNT+1)
- V05 N09 E
  verify 01102 code
- V05 N08 E
  Record:
  R1 _____ (ALMCADR)

Contact MSFN - Problem may be determined for post-flight analysis

(2)

12 CMC Failed

(1) CMC not functional

(2) CMC not functional

Drawn by Dennis Beatty 11/1/67

11-13-67 DLB

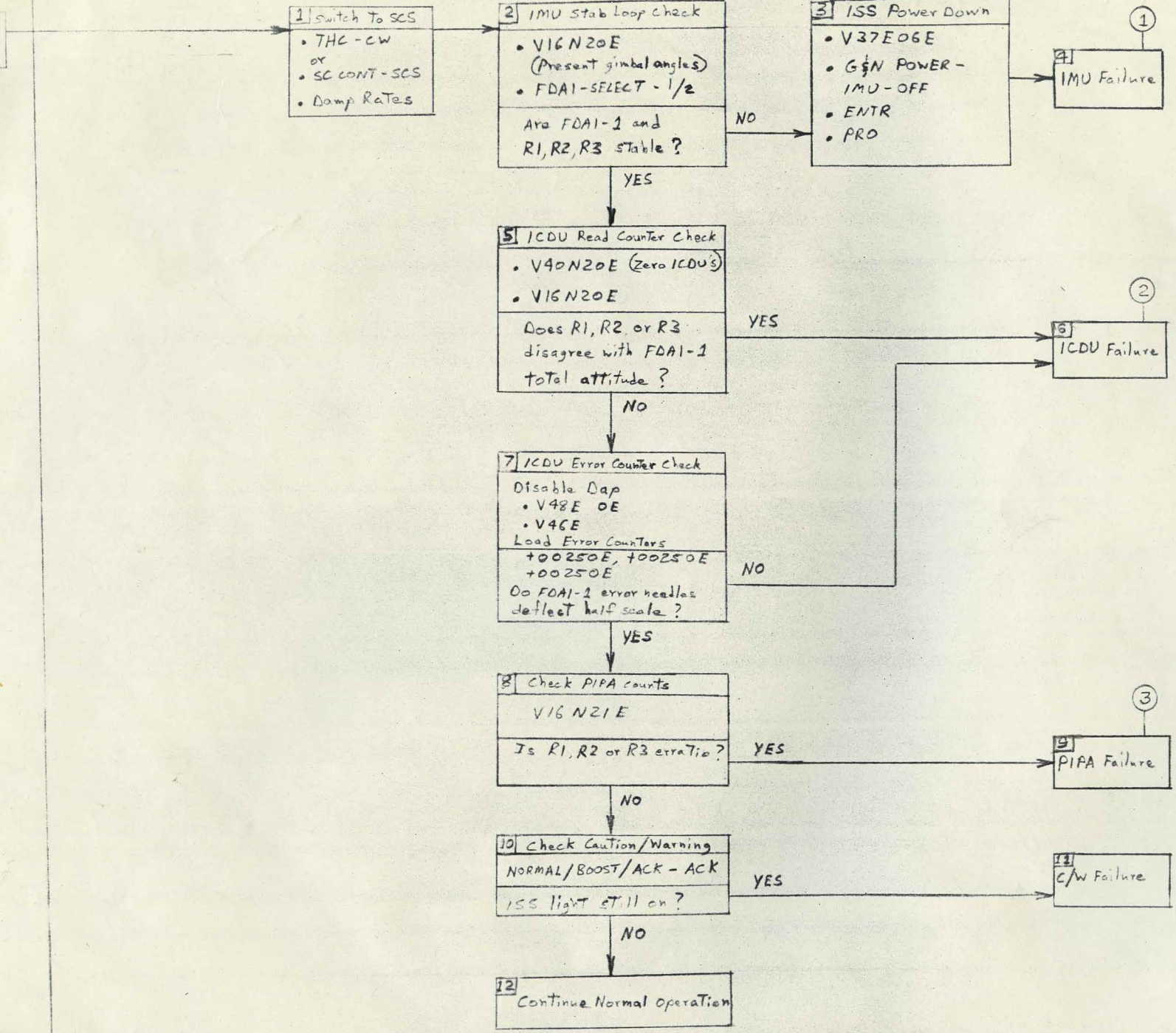
SYMPTOM

PROCEDURE

REMARKS

ISS

ated by :



(1) IMU not functional

(2) IMU may be used as attitude reference only

(3) GNCS TVC and Entry lost

11-13-67
DLR

Al Sellers comments to mailf proc dated 21 Sept 67

SWIGERT J.R.B. 10-26-67

COMMENTS ON DG MEMO NO. 947

SYMPTOM 1.

✓ (A.) CMC SELF TEST SHOULD BE EXPANDED TO ALLOW SELF CONTAINED ON BOARD TROUBLE SHOOTING.

✓ (B.) BOX 6 IS CANNOT BE RELATED TO BOX 5. NO OPERATION IN STANOBY.

✓ C. EXIT OF YES ON BOX 4 RETURNS TO CMC SYMPTON. LOCK IN "SMALL" CIRCLE.

my comment 3

✓ (D.) POWER CONSIDERATION CHECK SHOULD BE FIRST.

E. GENERALLY IF RUPT LOCK, TC TRAP, OR PARITY FAIL IS CAUSE, THE CME WILL IN SOME CASES BE LOCKED UPPED. HOW IS CMC TROUBLE SHOOT IN THIS CASE?

Can this happen?

2. THE ISS MODE IN WHICH THE ISS FAILURE LIGHT COMES ON DETERMINES THE ISS INITIAL TROUBLE SHOOTING STATUS. ICDU PROBLEMS COULD IMPACT COARSE ALIGNMENT BUT HAS NO IMPACT ON NORMAL ISS STABLE LOOP OPERATION. ISS CAN PROVIDE A GOOD REF. WITH ICDU FAILURES!

J.Q.P.
10-26-67

3. A. TRACKER FAIL MEANINGLESS TO APOLLO. (COCDU FAILURE) Flus refers to Rend Radar fail on LM.

B. IF FAILURE IS C/W, WHAT IS ALTERNATE MEANS OF MONITORING PGNS INDICATION.

5. GIMBAL LOCK LIGHT INDICATION AND TRUE IMU GIMBAL LOCK ARE DIFFERENT. DIFFERENCES SHOULD BE EXPLAINED.

6. A. CMC SELF TEST SHOULD BE EXPANDED TO ALLOW SELF CONTAINED ON BOARD TROUBLE SHOOTING.

B. ALSO CAUSED BY PROGRAM ALARM.

7. ~~A. Ref. 3-A~~ ABOVE. yes,

Valid B. WHAT TO DO IF FAILURE LIGHT COMES ON DURING TVC MODES.

not valid too many complicated to mention C. WHAT CONDITIONS TURN ON LIGHT.

separate symptom MASS D. WHAT ABOUT MANUAL OPTICS DRIVE FAILURES.

00112 WHAT IF IN CMC MARK PROGRAM?

J.R.B.
10-26-67

ADDITIONAL FAILURE CONDITIONS THAT SHOULD BE INVESTIGATED BY MIT AND INCORPORATED INTO MALFUNCTION DIAGRAMS IF APPLICABLE.

NOTE: IT IS NAR'S UNDERSTANDING THAT FAILURES IN "ANY" OF THE DAP WILL NOT GENERATE A FAILURE QUE.

1. FAILURES IN OCDU'S DAC THAT RESULT IN A MAX ±5V OUTPUT TO THE SCS SERVO AMP.

   RESULT: G&N AUTO TVC NOT OPERABLE, BUT G&N CAN STILL BE USED FOR POWERED NAVIGATION AND TO PROVIDE ERROR SIGNALS TO THE FDAI FOR MTVC.

2. FAILURE IN OUTPUT CHANNELS 5 & 6 GIVING A CONSTANT JET COMMAND.

   CORRECTION: DISABLE JET USING CHANNEL SWITCHES. RECALL R03 AND DISABLE RELATED QUAD.

3. FAILURE IN INPUT CHANNELS 31 AND 32 OF CMC. (ACTS LIKE A ROTATION, TRANSLATION OR MIN. IMPULSE [redacted] CONTROL INPUT OR LACK OF RESPONSE TO INPUT.)

   CORRECTION: DETERMINE CONTROL MODE OPERABLE AND AVOID ALL FAILURE IMPACTED MODES.

J.R.B.
10-26-67

4. RCS JET NOT FIRING WHILE IN CMC CONTROL MODE. DETERMINED BY FDAI OR OUT OF WINDOW.

FAIL APPRORIATE QUAD AND DAP WILL COMPENSATE FOR THIS BY FIRING A SINGLE JET LONGER.

5. GENERALLY MIT SHOULD INVESTIGATE ALL G&N FAILURES THAT COULD CAUSE SPS GIMBAL HARDOVERS, RCS JETS ON WITH NO COMMAND OR NO RCS FIRING WITH A COMMAND. THIS INFORMATION SHOULD BE REFLECTED IN MALFUNCTION DIAGRAMS.

6. THE FDAI TOTAL ATTITUDE AND ATTITUDE ERROR SHOULD BE USED IN ISS AND ICDU TROUBLE SHOOTING.

29 [illegible] 68

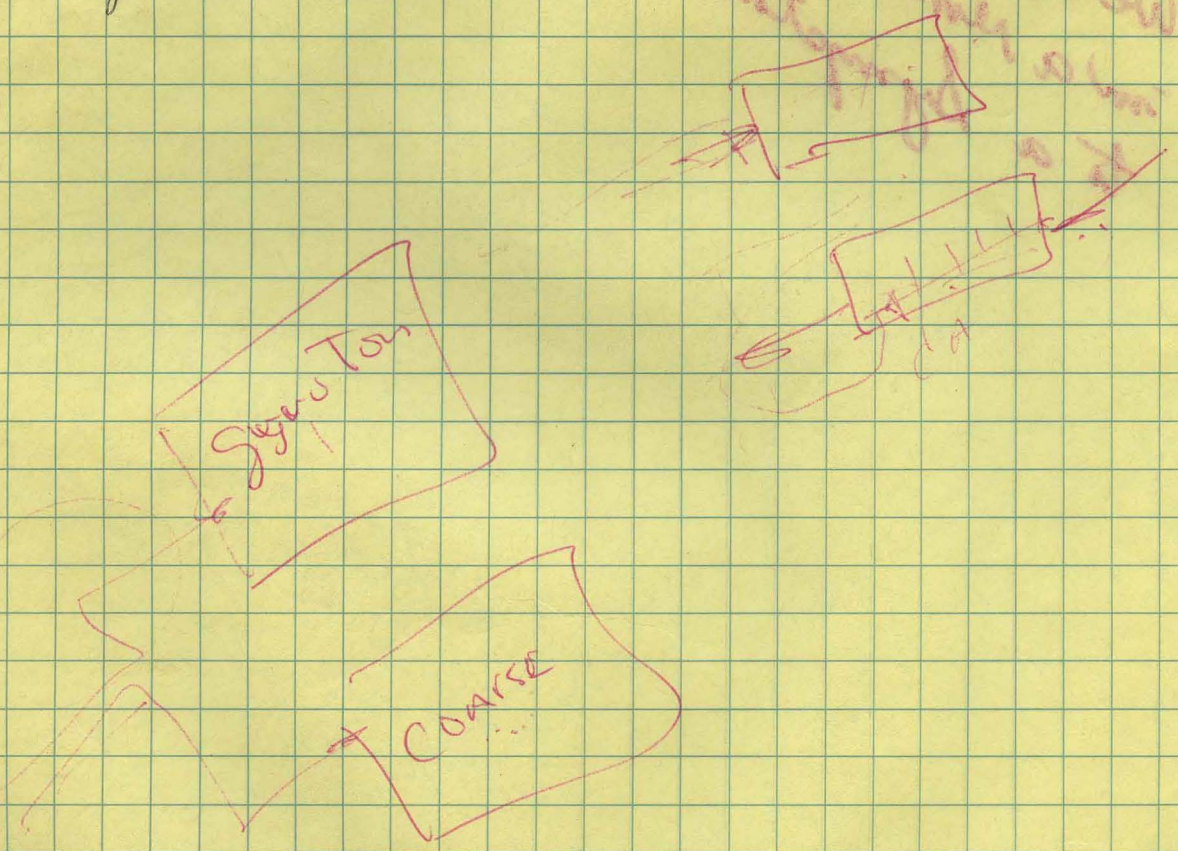
JACK,

I DON'T KNOW WHAT THE LATEST SM RCS MALF PROCEDURES LOOK LIKE. I HAVE THE EDITION THAT WE USED FOR THE FLIGHT SAFETY REVIEW BOARD. LOOKING AT THOSE, IT MIGHT BE A GOOD IDEA TO ADD A REMARK #14 TO SYMPTOM BLOCK 1d. [redacted] STATING THAT THE MANF PRESS MAY INCREASE TO > 200 PSI DURING BOOST & STAY HIGH UNTIL THE SM RCS JETS ARE FIRED. THIS CONDITION EXISTS BECAUSE THE He REGS ARE REFERANCED TO AMBIENT AND ARE LOCKED UP ON THE GROUND PRIOR TO LAUNCH.

Lou Ramon
X 4371

we call this out in a remark attached to a Symptom.

except with V5 N9 E



f3026

MAY 24 1968

Herr Swigert:

While tripping through the Malfunction Procedures I came across the following, which you may use as you see fit:

O_2 FLOW HI Step 38 - should be ENTER CAB PRESS TO TEST pb push and release. The flow is obviously high while the pb is pushed - the question is does it drop ~~when~~ to normal when the button is released.

we say "push - several times" this should be sufficient

O_2 FLOW LOW - From Step 1 - Surge tank pressure Low - ~~I suggest~~ going to a box to read cabin pressure. If ~~not~~ High go to ECS Symptom 3; if ~~not~~ High, go to symptom 4. With the present procedure a plumbing leak upstream of the flow rate sensor would cause the operator to start at 2, go to 4, then to 13.

we changed this procedure rather drastically. See new figure

SURGE TANK PRESS LOW - A flow restriction (Box 8) would not cause Low flow at the Flow Rate sensor until the surge Tank is empty. Box's 7 + 9 are therefore unnecessary. I suggest combining Low and normal from Box 2 to Box 3 and deleting Box's 7+9.

SPS ROUGH ECO - I can't get the story straight yet, but there are apparently some pressure surge in the SPS plumbing that might make it wise to wait 6 seconds after a shut down before attempting a restart. As best I understand it - they don't know what causes the surges and therefore really don't know the effect.

yes we do this

POWER DISTRIBUTION SYMPTOM - Loss of an AC Bus is time critical because of the Fuel Cell Pumps - with the fuel cell cooling loop disabled and with the pumps disabled + have failure (flooding) is probably 5 minutes. Perhaps we should have a caution note to this effect somewhere in this procedure to insure that the crew realizes that loss of an AC Bus requires prompt action to protect the fuel cells.

we do call out for transferring FC pumps to redundant AC bus upon loss of an AC bus

Charlie Hames

R01

NAA feels that the crew should be able to select any program at any time.

The act of selecting a new program by DSKY entry is a conscious deliberate act. Therfore the crew should not be prevented by interlocks from going to a desired program. —

Such interlocks limit the capacity of the crew to use the G & N System.

a1

See pencil note p 237

R-54

NAA explained a situation during the running of R52 that caused a computer back up. At card 225 the crew was to switch optics to CMC mode and key in Enter. They inadvertently keyed in Enter first, and the CMC froze. They could get the CMC back on the line by keying in fresh start (V36E) and starting the program all over. They felt there should have been some method of correcting the error and continuing on at that point.

Programs Not Yet Incorporated.

P01 - Pre-launch Initialization.
P02 - Gyro Compassing.
P03 - Optical Verification of Azimuth.
P04 - Inertial Reference.
P07 - Systems Test (non-flight)
P65 - Up Control.
P66 - Ballistic.

Routine Not Yet Incorporated.

R 24 Septant Search.

Program Recommendations

1. Modify R01
   to flash "operator alarm" for information only. This routine should not prevent the crew from going into a desired program

2. Eliminate R02.
   Replace this by checklist items

f3033

1060
1101

R-50

NAA position was that this routine should be available for manual call up by DSKY entry. If this could be done we could coarse align on selected stars visually.

?

R-50

This routine is not necessary for manual coarse align. A simpler way of accomplishing coarse align while holding some attitude is to use

V

ROZ

NAA feels this is an unnecessary routine.

Crew is knowledgeable and trained. Thus routine could be eliminated, and check list items would suffice, saving space.

R22

NAA felt that the alarm light (card 40) should be deleted because this routine would only be selected when P-20 was in process. This looks like a double check on P-20 and therefore not needed.

R-22

This routine is used in

P-34
P-35

It would only be called up in the listed programs if state vector update is desired, in which case P-20 would have to be in process. These programs can also be accomplished without state vector update. Concur with NAA

R 21

NAA felt that assumption 2 should be modified or amplified to decrease the possibility of losing marks due to high frequency of marks.

Either

1) Force computer to process marks faster than 1 each minute.

or 2) Emphasize that marks should be made at a rate not faster than 1 per minute.

P40 or P41 Thrusting (SPS) or (RCS)

Problems in G & N Displays

In case of Gimbal Hardover the action of going to MTVC on rotation controller blanks the register displays of T_G, ΔV_G, ΔV_m. Since the SCS accelerometer is the EMS accel on the X axis, one does not know how much the out of plane errors have been.

This could be a critical situation if an out of plane burn were being made. A sudden gimbal hardover could cause one to "DE ORBIT" unintentionally — since to get back into the prog, must go to "clear or fresh start"; then P00 and then pre thrusting and thrusting Prog and wait for 5 min lockout.

P51- IMU Orientation

NAA felt there should be some method where by the pilot can have displayed to him a coarse reference attitude for orientation.

This would require a new routine for displaying a coarse identical attitude.

NAA General Comments.

Programs do not give the capability or flexibility needed. and limit the crew in the use of the G & C system.

In answer to a question; if they (Bill Campbell) had a choice in programming changes, they would: remove R01 and R02; many flags and interlocks; give the crew the capability to select any program at any time; provide the capability to fine align the IMU to any attitude; reduce the number of "proceeds"